



Col·lecció  
INSTRUMENTA



55

ECONOMÍA ROMANA.  
NUEVAS PERSPECTIVAS  
THE ROMAN ECONOMY.  
NEW PERSPECTIVES

José Remesal Rodríguez (ed.)



UNIVERSITAT DE  
BARCELONA

Edicions







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Barcelona 2017



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Economía romana : nuevas perspectivas = The Roman economy : new perspectives. –  
(Col·lecció Instrumenta ; 55)

Referències bibliogràfiques  
Textos en castellà, italià i anglès  
ISBN 978-84-475-4150-8

I. Remesal Rodríguez, José, ed. II. Títol paral·lel: Roman economy III. Col·lecció:  
Instrumenta (Universitat de Barcelona) ; 55  
1. Economía 2. Comerç d'aliments 3. Imperi Romà, 30 aC-284 4. Bètica (Província  
romana) 5. Roma

© Edicions de la Universitat de Barcelona

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08028 Barcelona

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comercial.edicions@ub.edu

www.publicacions.ub.edu

1.ª edición: Barcelona, 2017

Director de la colección: JOSÉ REMESAL

Secretario de la colección: ANTONIO AGUILERA

CEIPAC

<http://ceipac.ub.edu>

Unión Europea: *ERC Advanced Grant* ERC-2013 ADG-340828.

Gobierno de España: DGICYT: PB89-244; PB96-218; APC 1998-119; APC 1999-0033; APC 1999-034; BHA 2000-0731; PGC 2000-2409-E; BHA 2001-5046E; BHA2002-11006E; HUM2004-01662/HIST; HUM200421129E; HUM2005-23853E; HUM2006-27988E; HP2005-0016; HUM2007-30842-E/HIST; HAR2008-00210; HAR2011-24593; HAR2015-66771-P (MINECO/FEDER, UE).

MAEX: AECl29/04/P/E; AEClA/2589/05; AEClA/4772/06; AEClA/01437/07; AEClA/017285/08.

Generalitat de Catalunya: *Grup de Recerca de Qualitat*: SGR 95/200; SGR 99/00426; 2001 SGR 00010; 2005 SGR 01010; 2009 SGR 480; 2014 SGR 218; ACES 98-22/3; ACES 99/00006; 2002ACES 00092; 2006-EXCAV0006; 2006ACD 00069.



MINISTERIO  
DE CIENCIA  
E INNOVACIÓN



The research leading to these results has received funding from the European Research Council under the European Union's Seventh Framework Programme (FP7/2007-2013). ERC grant agreement n° ERC-2013-ADG340828.

Montaje: Mateo González Vázquez

Ilustración de la cubierta: *Naturaleza muerta*. Casa de Iulia Felix, Pompeya.

Impresión: Gráficas Rey

Depósito legal: B-3.846-2017

ISBN: 978-84-475-4150-8

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## PRÓLOGO

Recogemos en este volumen una serie de trabajos dedicados, unos a mostrar algunos aspectos vinculados a la investigación actual, relacionados con el estudio del *instrumentum domesticum* y la economía romana. Otros son la primera muestra del desarrollo de los nuevos enfoques surgidos del proyecto ERC Advanced Grant *Production and Distribution of Food during the Roman Empire: Economic and Political Dynamics* (EPNet) (ERC-2013-ADG 340828).

Hasta ahora, la aplicación de métodos formales, nacidos fuera del ámbito de la investigación histórica, está poco desarrollada dentro de nuestra especialidad. La “ominosa cuestión” de los estudios de Historia Antigua es la falta de datos. Los modelos interpretativos de la economía antigua han partido siempre de análisis deductivos, que dependen siempre del grado de conocimientos del investigador y de sus apriorismos. A lo largo de estos años hemos conseguido reunir una gran cantidad de datos, muchos de los cuales pueden ser presentados como datos seriales gracias a la información obtenida en el Monte Testaccio. Es ésta una circunstancia, la abundancia de datos y el poder ordenar cronológicamente muchos de ellos, es lo que permite los nuevos enfoques propuestos. En última instancia se trata de confrontar los modelos y explicaciones hasta ahora ofrecidas dentro del ámbito histórico, con modelos formales nacidos dentro del ámbito de las ciencias matemáticas y en el ámbito de las ciencias de redes.

Además, estamos haciendo migrar nuestra base de datos CEIPAC, ya puesta en Internet en 1995, a un sistema ontológico de bases de datos, en el que, gracias a un sistema de metadatos, podamos interrelacionar diversas bases de datos que amplíen nuestros conocimientos y la capacidad de relacionar múltiples aspectos de la investigación.

Dado que los trabajos presentados proceden de ámbitos científicos en los que los sistemas de citación son diversos, se han respetado los sistemas propuestos por cada uno de los autores.



## INTRODUCCIÓN: ECONOMÍA ROMANA. NUEVAS PERSPECTIVAS

JOSÉ REMESAL RODRÍGUEZ

Universitat de Barcelona

*“For me archaeology is not a source of illustrations for written texts, but an independent source of historical information, no less valuable and important, sometimes more important, than the written sources. We must learn and we are gradually learning how to write history with the help of archaeology.”*

(M. ROSTOVITZ, *Iranians and Greeks in south Russia*, Oxford 1922, VIII)

En los últimos años hemos asistido a un debate sobre el significado de la economía en época imperial romana.

Dos han sido las posiciones que han polarizado por largo tiempo la discusión. La visión “primitivista” y la visión “modernista”. Los primeros pretenden resaltar las diferencias entre la economía antigua y la economía actual. Los segundos, tras la propuesta de M. Rostovtzeff, ponen de manifiesto la similitud entre el sistema económico romano y nuestro mundo moderno.

Hoy día, tal vez como superación de esta controversia se defiende que, más bien, se trata de una cuestión de escala y qué fenómenos, que hoy consideramos propios del mundo moderno, también se dieron en el mundo romano aunque con un alcance, una escala, diferente.



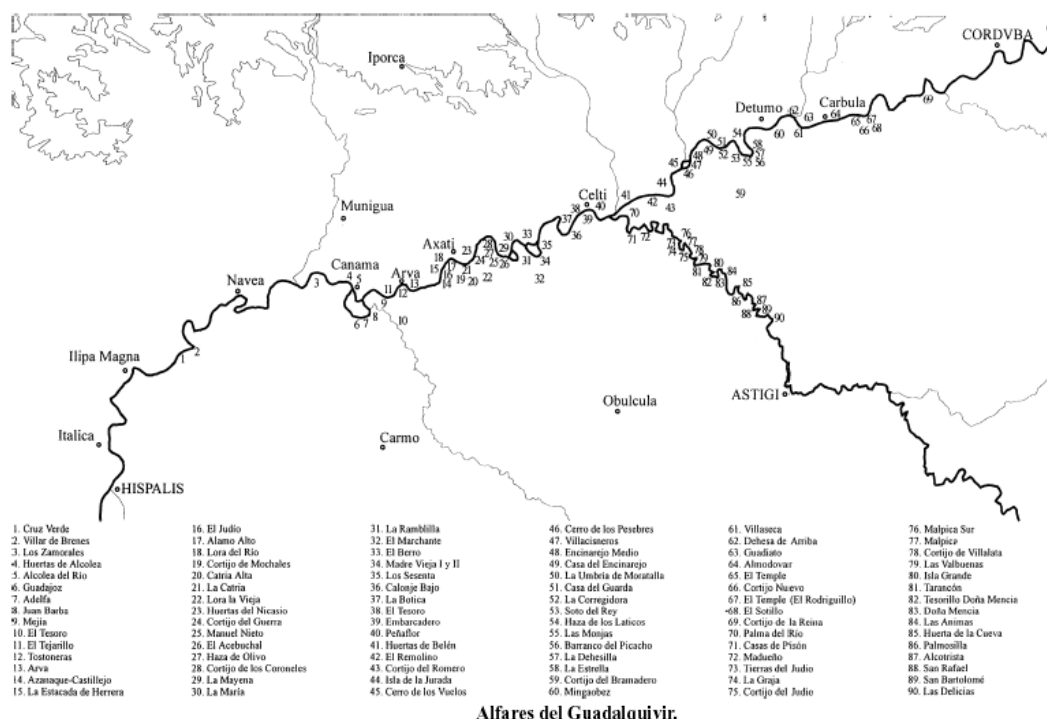
Me he declarado más Rostovzeffriano, no porque acepte toda su interpretación sobre la economía antigua, sino por aceptar el criterio que refleja la frase, antes citada, sobre el carácter de las fuentes arqueológicas. Y sobre la necesidad de utilizar las fuentes arqueológicas para el estudio de la economía antigua. Elevar a la categoría de documento histórico un material arqueológico no es tarea fácil. El problema consiste en saber convertir los datos arqueológicos, limitados y a veces contradictorios, en fuentes históricas capaces de darnos información sobre la economía, la sociedad o la política del mundo antiguo.

Pretendía hacer un análisis de la economía romana partiendo de dos criterios: uno, el criterio Rostovzeffriano de que para estudiar la vida económica del mundo antiguo era preciso prestar atención a los restos arqueológicos; el otro, partíamos de la idea de que para hacer progresar nuestros conocimientos debíamos aplicar un método de estudio micro-analítico.

Para ello era necesario elegir un aspecto bien delimitado de la economía antigua. Decidimos elegir, como caso de estudio, un aspecto relacionado con algo fundamental en cualquier sociedad humana: la consecución de alimentos. Fijándonos, particularmente, en el estudio del aceite bético.

La información sobre el aceite bético se encontraba en una situación paradigmática:

Primero, la abundante producción de Ánforas olearias en la Bética permitía pensar que se trataba de un producto destinado en gran medida a la exportación. Conocemos casi un centenar de centros productores de ánforas olearias béticas, las llamadas tipo Dressel 20, situadas a las orillas de los ríos *Baetis* (Guadalquivir) y *Singilis* (Genil) en el triángulo limitado por las ciudades de *Hispalis* (Sevilla), *Corduba* (Córdoba) y *Astigi* (Écija) (Fig. 1). Estas ánforas fueron frecuentemente selladas antes de la cochura.



**Fig. 1. Plano de las alfarerías del Valle del Guadalquivir.**

Segundo, la existencia del monte Testaccio (Roma) (fig. 2), donde el 85% de los millones de ánforas allí contenidas son ánforas olearias béticas, obligaba a pensar que la capital, Roma, había sido abastecida, sistemáticamente, con aceite de oliva bético. Ya Dressel propuso que el Testaccio debió iniciarse en época de Augusto. En el Testaccio no sólo se han hallado miles de sellos en estas ánforas, sino también los llamados *tituli picti*: las “etiquetas” que los romanos escribían sobre cada ánfora, entre cuyos datos figuran: la tara del ánfora y el peso neto del aceite contenido. El nombre del/los personajes que transportaron el ánfora; un control aduanero/fiscal en el que se hace constar: el distrito fiscal desde el que se exporta el ánfora. La confirmación del peso neto contenido; los nombres de las personas que intervinieron en la realización de este control; el año de expedición del ánfora, indicado mediante la fecha consular (Fig. 3).



Fig. 2. Vista aérea del Monte Testaccio (Roma).

- Titulatura ideal de un ánfora Dressel 20 del último cuarto del siglo II mostrando las inscripciones realizadas en “origen”.

sello LSAR (procedente de Encinarejo Bajo)

**α:** Tara. CI: 101 libras romanas.

**β:** nombre de los comerciantes.  
*II(duorum) Iulior(um) Cosmi et Fausti*  
 (Los dos Julios Cosme y Fausto)

**γ:** peso del aceite contenido.  
 CCVVVI: 216 libras romanas.

**δ:** control fiscal.  
*Commodo et Laterano cos (154 d.C.) /*  
*R(ecognitum) XXVIII CCXVI /*  
*Flavianae AA s- Hermeros*  
 (Controlado en el puesto 28, en el año 154 d.C.  
 por Hermeros del control de Flaviana  
 contiene 216 libras de aceite).

**ε:** control de almacenaje. XX: 20.

**ζ:** control de almacenaje. XX: 20.

Fig. 3. Ánfora Dressel 20 y su epigrafía.

Todo ello permite disponer de un abundantísimo material, que al disponer de dataciones absolutas, gracias a la datación consular, permite establecer series precisas de documentos. Hecho rarísimo en Historia Antigua.

Tercero, La consistente presencia de ánforas olearias béticas en los campamentos militares de *Britannia*, *Germania* y *Raetia* nos llevó a pensar que la presencia masiva de un producto exótico, sólo podía explicarse si aceptamos que la intendencia del ejército se ocupó de ello.

Este punto de partida nos ha llevado a proponer un nuevo modelo explicativo de la economía romana y de la relación entre el control de alimentos y el desarrollo político de Roma, que es el tema de nuestro proyecto.

La creación de un nuevo régimen político por Augusto cambió el sistema de relaciones en el mundo romano. Augusto tenía como pilares de su poder el ejército, un ejército creado y pagado por él, y el control de la plebe de Roma, único grupo social que podía contraponerse a la voluntad del senado. Augusto y sus sucesores utilizaron continuamente el título de *tribunus plebis* y la *tribunicia potestas* que le convertía en cabeza de ese *populus* que entregó su poder político en manos del emperador a cambio, como se lamentaba Juvenal, de *panem et circenses*.

Tradicionalmente se defendía que cada unidad del ejército, a través de su *praefectus castrorum* se ocupa del abastecimiento de la misma.

Por nuestra parte, propusimos que el abastecimiento militar provenía de tres niveles distintos:

- Las productos y materiales que la misma unidad podía producir (*fabricae legiones*, *prata legiones* etc.)
- Productos recibido de la provincia en la que estaba acantonada la unidad (p.e. la región de los ubios, Colonia, era gran productora de trigo, del que, sin duda, podían abastecerse la unidades militares de la región.
- Productos que era necesario trasladar desde otras regiones (metales, o cualquier otro producto necesario a la unidad, inexistente en el lugar donde se acantonaba la unidad militar)

El análisis de toda la documentación literaria, arqueológica y epigráfica a nuestro alcance nos llevó a proponer la existencia de una oficina de la *annona militaris*, pues para el acarreo de estos últimos productos era necesaria la existencia de un servicio de abastos y logística ya desde inicios del principado.

Esta idea ha sido aceptada por muchos colegas, que la exponen ya como una *communis opinio*, otros, sin embargo, siguen discutiéndola.

Por lo que respecta al abastecimiento de Roma la opinión común era que el emperador sólo tenía que ocuparse de acarrear a Roma el grano necesario para las *frumentationes*, una limitada cantidad de grano que recibía un limitado grupo de ciudadanos romanos. Y que el conseguir dicho grano era la función de la *praefectura annonae*.

Por mi parte he defendido que la función de la *praefectura annonae* era acarrear los suficientes productos básicos, sobre todo grano y aceite, necesarios a toda la población de Roma. Para mantener la paz social, el emperador tenía que asegurar que en Roma no se produjesen hambrunas. En mi opinión la *praefectura annonae* era la oficina que controlaba tanto el abastecimiento de Roma como del ejército.

Desde la creación del grupo CEIPAC (Centro para el Estudio de la Interdependencia Provincial en la Antigüedad Clásica), en 1989, se pretende contrastar estas ideas a través del estudio sistemático de los documentos llegados hasta nosotros. En este sentido la contribución de CEIPAC se ha distinguido por:

- Crear una base de datos de epigrafía anfórica, donde en la actualidad existen más de 40.000 registros, que contienen alrededor de un millón de datos.
- Iniciar, en 1989, excavaciones en el monte Testaccio.
- Realizar estudios sea relativos a la zona de producción, en la Bética, sea relativos al estudio de la distribución del aceite bético en determinadas regiones del imperio.
- Desarrollar estudios dedicados al análisis de la producción y consumo de otros productos: vino y conservas de pescado.

Estas ideas han condicionado la discusión actual sobre la economía romana, donde se discute sobre la intervención del Estado en el desarrollo económico del imperio. Sobre el papel que el control de alimentos tuvo en la evolución de la política y de la administración romana y, de qué modo, las provincias “productoras de alimentos” tuvieron una mayor o menor influencia en el desarrollo y evolución del imperio romano.

Nuestro proyecto EPNet pretende abordar estas cuestiones desde perspectivas y ciencias distintas, con la esperanza de poder validar o no muchas de las cuestiones hoy discutidas.

#### NOTA DE LECTURA.

Las ideas aquí expuestas de una manera sintética han generado un volumen muy significativo de publicaciones tanto dentro del grupo CEIPAC, como por otros autores vinculados, de un modo más o menos directo, a nuestras investigaciones, así como entre los investigadores que critican nuestros puntos de vista. En dos direcciones han influido nuestros trabajos: en el análisis arqueológico/epigráfico y en la discusión más general sobre la evolución de la administración del imperio Romano.

El conjunto de las actividades del CEIPAC se recogen en nuestra web ([ceipac.ub.edu](http://ceipac.ub.edu)) véase también: J. Remesal, A. Aguilera, M. García, D. J. Martín-Arroyo, J. Pérez y V. Revilla, Centro para el Estudio de la interdependencia Provincial en la Antigüedad Clásica (CEIPAC). *Pyrenae. Número especial 50è aniversari (1965-2015)*. Barcelona 2015.

Una síntesis con abundante bibliografía y la indicación de las influencias y discusiones generadas en torno a nuestros trabajos en: J. Remesal Rodríguez, *La Bética en el concierto del imperio romano*. Madrid 2011.





## L'INSTRUMENTUM INSCRIPTUM DA CURIOSITÀ ANTIQUARIA A FONTE PER LA STORIA ECONOMICA E SOCIALE DEL MONDO ROMANO

ALFREDO BUONOPANE

Università di Verona

Manca finora, come giustamente sottolinea Ivan di Stefano Manzella<sup>1</sup>, una storia degli studi relativi all'*instrumentum inscriptum*<sup>2</sup>, impresa che forse sarà impossibile da portare a compimento sia per un singolo sia per un gruppo di ricerca, ma che forse varrebbe la pena di tentare, non solo per conoscere meglio le vicende del collezionismo epigrafico attraverso i secoli, ma, soprattutto, per approfondire le varie fasi del passaggio dall'erudizione antiquaria alla scienza epigrafica e per conoscere meglio, sotto il profilo della storia culturale, "l'evoluzione delle idee e delle conoscenze"<sup>3</sup> che riguardano questa particolare classe di manufatti.

E, in effetti, gli oggetti di uso quotidiano, in particolare quelli che recano un testo, sia esso impresso, dipinto, inciso o graffito, hanno, almeno dalla seconda metà del XVI secolo, attirato l'interesse di appassionati collezionisti<sup>4</sup> e di eruditi, che spesso li hanno presentati, talora con

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<sup>1</sup> I. DI STEFANO MANZELLA, 'Gaetano Marini e l'*instrumentum inscriptum*. A proposito del codice Vat. Lat. 9110', in M. BUONOCORE (ed.), *Gaetano Marini (1742-1815), protagonista della cultura europea. Scritti per il bicentenario della morte*, Città del Vaticano 2015, pp. 1166-1167.

<sup>2</sup> Di notevole interesse, anche se circoscritto ai secoli XVIII e XIX, è L. TABORELLI, *Sull'«instrumentum domesticum». Uno sguardo originale alla genesi degli studi*, Roma 2012.

<sup>3</sup> L. Taborelli, *Sull'«instrumentum domesticum»...*, p. 7.

<sup>4</sup> Sono valide anche per questo periodo le considerazioni esposte, sul finire dell'Ottocento, da R. LANCIANI, *Topografia di Roma antica. I commentarii di Frontino intorno le acque e gli acquedotti. Silloge epigrafica aquaria*, Roma 1881, p. 421 (traggo la citazione da I. DI STEFANO MANZELLA, 'Gaetano Marini...', p. 1166): "pochi sono i privati (parlo specialmente

interpretazioni erranee, quando non del tutto fantasiose, nelle loro opere. Tralasciando gli esempi, pur illustri, di Onofrio Panvinio (1530-1568), che Scipione Maffei considerava, a torto secondo Gaetano Marini<sup>5</sup>, il primo a essersi occupato degli “impronti de’ mattoni”<sup>6</sup>, Pirro Ligorio (1513-1583) e Martin Smetius (1525 circa- 1588)<sup>7</sup>, mi limiterò<sup>8</sup> qui a menzionare la fortunata silloge di Jan Gruter (1560-1627), dove in tre pagine<sup>9</sup>, nell’ambito della sezione delle iscrizioni “operum et locorum publicorum”, si pubblicano *fistulae aquariae* e bolli doliari (fig. 1) o il singolare libretto di Paul Pétau (1568-1614), più volte ripubblicato<sup>10</sup>, che in alcune tavole presenta vasi, strigili, signacula, lucerne, pesi (fig. 2), o il volume di Lodovico Moscardo (1601-1681)<sup>11</sup>, dove un interessante *operculum* di anfora (fig. 3) viene interpretato come la chiusura di un’urna cineraria recante il nome del defunto<sup>12</sup>, o ancora, sul finire del Seicento l’importante lavoro di Raffaele Fabretti (1618-1700), nel quale un intero capitolo, il VII, è dedicato a bolli doliari, pesi, lucerne, *signacula*, vetri<sup>13</sup>.

Questo atteggiamento, che vede nei manufatti iscritti più degli oggetti di curiosità, ideali per impostare lunghe elucubrazioni dotte, che dei documenti per la ricostruzione storica, non muta neppure nel corso del Settecento, almeno nella prima metà. Si vedano gli esempi offerti non solo da modesti eruditi, come nel caso del celebre vaso diatremo, noto come “coppa Trivulzio”, che serve da spunto a Stanislao Santinelli per pubblicare, nel *Giornale de’ Letterati d’Italia*<sup>14</sup>, una tanto prolissa quanto poco originale dissertazione sul modo di brindare presso Romani<sup>15</sup>, ma anche di studiosi di spicco, come, fra i molti che si potrebbero citare, Ludovico Antonio Muratori (1672-1750) e Scipione Maffei (1675-1755). Il primo nel *Novus Thesaurus* pubblica, senza commento e alla rinfusa, bolli doliari, pesi, lucerne, *fistulae*, *signacula* e altri vari materiali iscritti<sup>16</sup>, mentre il secondo, che pure è uno dei fondatori dell’epigrafia come scienza<sup>17</sup>, nonostante avesse riservato uno spazio apposito all’*instrumentum inscriptum* nel suo *Prospectus*, l’avanzatissimo progetto di un *corpus* globale di iscrizioni antiche e medievali - *figlinarum signa, plumbei tubuli, ceteraque id genus, ubi Consules inscribuntur, distribuentur in seriem*, scrive, infatti<sup>18</sup> - in realtà, poi, si limita a presentare, senza alcun commento, nel suo *Museum Veronense* tre bolli doliari (fig. 4), quindici *signacula* e del vasellame

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dei paesi al di là delle Alpi), che posseggano iscrizioni in marmo ed in pietra, ma non v’è amatore di anticaglie in Italia e fuori, che non posseda nel suo gabinetto figuline, bronzi, ori, argenti, gemme, piombi, ossi, avori, forniti di iscrizioni”.

<sup>5</sup> G. MARINI, *Iscrizioni antiche doliari pubblicate per cura dell’Accademia di conferenze storico-giuridiche dal Comm. G. B. de Rossi con annotazioni del dott. Enrico Dressel*, Roma 1884, p. 7.

<sup>6</sup> S. MAFFEI, *Verona illustrata. Parte Prima. Contiene l’istoria della città....alla venuta in Italia di Carlo Magno*, Verona 1732, p. 191.

<sup>7</sup> Si veda quanto scrive G. MARINI, *Iscrizioni antiche doliari pubblicate...*, p. 7.

<sup>8</sup> Per altri autori si veda I. DI STEFANO MANZELLA, ‘Gaetano Marini...’, pp. 1175-1180.

<sup>9</sup> J. GRUTER, *Inscriptiones antiquae totius orbis Romani in absolutissimum corpus redactae*, Amstelædami 1602, pp. CLXXXII-CLXXXIV.

<sup>10</sup> P. PÉTAU, *Antiquariae supellectilis portiuncula*, Parisii 1610, tavv. 14-18.

<sup>11</sup> L. MOSCARDI, *Note ovvero memorie del Museo di Lodovico Moscardo nobile veronese*, Padova 1656, pp. 55-57.

<sup>12</sup> L’*operculum* è stato recentemente studiato da S.M. MARENGO, ‘Pilota Arri Q. S.’, in M. SILVESTRINI (ed.), *Le tribù romane*, Atti della XVI<sup>e</sup> Rencontre sur l’épigraphie, Bari 2010, pp. 437-442.

<sup>13</sup> R. FABRETTI, *Inscriptionum antiquarum...explicatio et additamentum*, Romae 1699, pp. 496-544.

<sup>14</sup> A. BUONOPANE, ‘Archeologia, numismatica ed epigrafia nel «Giornale de’ Letterati d’Italia»’, in E. del Tedesco (ed.) *Il «Giornale de’ Letterati d’Italia» trecento anni dopo. Scienza, storia, arte, identità (1710-2010)*, Pisa-Roma 2012, pp. 271-280.

<sup>15</sup> S. SANTINELLI, ‘Lettera intorno a Brindesi del P.D. Stanislao Santinelli Somasco a S. E. il Sig. Francesco-giorgio Baron di Firmian...Cameriere di S. M. C. C.’, *Giornale de’ Letterati d’Italia*, vol. 36, 1724, pp. 171-183; si veda A. BUONOPANE, ‘La prima edizione della “coppa Trivulzio” e alcune osservazioni in margine a CIL, V, 6532 e Pais, Supplementa Italica, 1083,2’, pp. 223-226, in stampa.

<sup>16</sup> L.A. MURATORI, *Novus thesaurus veterum inscriptionum...hactenus praetermissarum*, Mediolani 1740, pp. 441-510.

<sup>17</sup> A. BUONOPANE, ‘Il “Prospectus universalis collectionis” di Scipione Maffei e la nascita della scienza epigrafica’, in G.P. ROMAGNANI (ed.), *Scipione Maffei nell’Europa del Settecento*, Atti del Convegno, Verona 1998, pp. 659-677.

<sup>18</sup> S. MAFFEI, *Prospectus universalis collectionis Latinarum veterum, ac Graecarum...reique antiquariae studiosis hominibus exhibet, ac proponit*, Veronae 1732, p. 6.

in bronzo iscritto<sup>19</sup>. Fra le poche eccezioni meritano di essere segnalati Francesco Bianchini (1662-1729) e Bernard de Montfaucon (1655-1741). Il primo, eccezionale figura di studioso dai molteplici interessi, che spaziavano dall'astronomia all'archeologia, raccolse centinaia di schede, quasi sempre accompagnate da calchi cartacei, dei bolli doliari che venivano trovati a Roma fra il 1689 e il 1690, schede purtroppo rimaste inedite, come gran parte della sua produzione scientifica, e oggi conservate presso la Biblioteca Capitolare di Verona<sup>20</sup>. Francesco Bianchini comprende che anche i documenti considerati più umili sono importanti per la ricostruzione storica. Scrive infatti: "La verità per se stessa ha tanto di maestà, che in ogni vestigio suol conservarla; e dedica, per così dire, con la presenza, tanto la creta, quanto l'oro, tanto le immense moli delle piramidi e de' mausolei, quanto i piccoli ritagli di bronzo e di pelle"<sup>21</sup>. Per la prima volta, credo, i dati offerti dall'*instrumentum inscriptum*, come ha dimostrato Michela Sanfelici, sono utilizzati a fini storici: la frequente menzione sui laterizi urbani delle coppie consolari, e di conseguenza la possibilità di fissare date certe, gli consentivano di colmare diverse lacune nella seriazione cronologica del mondo romano, che era uno dei suoi principali interessi di studio<sup>22</sup>. Al secondo invece va riconosciuto sia il merito di aver contribuito in maniera decisiva alla conoscenza del corredo epigrafico dei manufatti in vetro<sup>23</sup>, sia un "eccellente intuito investigativo"<sup>24</sup>, che, come avviene per un *signaculum* conservato a Parigi<sup>25</sup>, lo porta a spingersi oltre la semplice pubblicazione del testo iscritto e ad approfondire, invece, con sorprendente modernità, gli aspetti economici e sociali<sup>26</sup>.

Il primo vero cambiamento nell'approccio allo studio dell'*instrumentum inscriptum* si ha, tuttavia, solo con Gaetano Marini (1742-1815), che tra il 1798 e il 1799, compone un fondamentale contributo (fig. 5) dedicato alle "antiche iscrizioni doliari", ai "Sigilli di Bronzo" e agli "Acquedotti di piombo"<sup>27</sup>, che purtroppo rimase inedito fino al 1884, quando fu pubblicato, sia pure omettendo i 322 *signacula* e *anuli signatorii* che l'autore aveva raccolto, a cura di Giovan Battista de Rossi e di Heinrich Dressel<sup>28</sup>. Come evidenzia Marc Mayer<sup>29</sup>, la sua modernità consiste non tanto nella sua originalità quanto nella capacità di far "parlare" il manufatto, di inserirlo in un preciso contesto archeologico, cronologico e storico, di porne in risalto gli aspetti prosopografici e, soprattutto, di aver scorto con chiarezza l'importanza di un tema "que más que una complementariedad factual con la "gran epigrafía", representaba un camino nuevo cargado de documentos esenciales para el conocimiento de la historia de Roma, especialmente en sus vertientes económica y social"<sup>30</sup>. E

<sup>19</sup> S. MAFFEI, *Museum Veronense, hoc est antiquarum inscriptionum atque anaglyphorum collectio...et ubicumque collecta*, Veronae 1749, pp. 111, 428, 470-471.

<sup>20</sup> Fondamentale rimane lo studio di M. SANFELICI, 'Bolli doliari urbani inediti in un manoscritto di Francesco Bianchini (Biblioteca Capitolare di Verona, Ms. CCCLXI). Notizie preliminari', in R. BERTAZZOLI, F. FORNER, P. PELLEGRINI, C. VIOLA (edd.), *Studi per Gian Paolo Marchi*, Pisa 2011, pp. 673-681.

<sup>21</sup> F. BIANCHINI, *La Istoria Universale provata con documenti, e figurata...da Francesco Bianchini veronese*, Roma 1697, p. 62.

<sup>22</sup> M. SANFELICI, 'Bolli doliari urbani...', pp. 678-679.

<sup>23</sup> L. TABORELLI, *Sull' 'instrumentum domesticum...*, pp. 151-157.

<sup>24</sup> I. DI STEFANO MANZELLA, 'Gaetano Marini...', p. 1176.

<sup>25</sup> CIL, XIII, 10022, 206.

<sup>26</sup> B. DE MONTFAUCON, *L'Antiquité expliquée en figures*, II, Paris 1719, p. 230; I. DI STEFANO MANZELLA, 'Gaetano Marini...', p. 1176.

<sup>27</sup> G. MARINI, *Le iscrizioni antiche doliari con note. Alle quali si danno per giunta quelle de' Sigilli di Bronzo e degli Acquedotti di piombo*, Cod. Vat. Lat. 9110.

<sup>28</sup> G. MARINI, *Iscrizioni antiche doliari pubblicate...*; sugli interventi operati sul manoscritto originale: I. DI STEFANO MANZELLA, 'Gaetano Marini...', pp. 1163-1168.

<sup>29</sup> M. MAYER, 'Gaetano Marini y el estudio del instrumentum inscriptum: notas sobre su contribución científica a través de la preparación y posterior publicación de sus Iscrizioni antiche doliari', in M. BUONOCORE (ed.), *Gaetano Marini (1742-1815)...*, pp. 1160-1162.

<sup>30</sup> M. MAYER, 'Gaetano Marini ...', p. 1162; I. DI STEFANO MANZELLA, 'Gaetano Marini...', p. 1185, sottolinea "la sua visione integrata dell'epigrafia dell'*instrumentum...* e il desiderio di accettare le sfide e i rischi che esso comporta".

questo anche se che egli si allinea alla tendenza, allora prevalente, che privilegiava lo studio dei marchi su laterizi, considerati maggiori apportatori di notizie rispetto alle iscrizioni su altri manufatti: “Intorno poi alle iscrizioni de’ vasi, delle lucerne, de’ sigilli e delle fistole acquarie, ho dovuto essere necessariamente ancora più breve; così sono quasi tutte di poca importanza, e solo degne di essere da curiosi raccolte”<sup>31</sup>. L’Ottocento poi, soprattutto dalla seconda metà, segna un rinnovato interesse per l’*instrumentum*, interesse stimolato dalla pubblicazione dei vari volumi del *Corpus Inscriptionum Latinarum*. Anche se Theodor Mommsen nel suo *Plan*<sup>32</sup> non menziona esplicitamente l’*instrumentum*, verso il quale sembra nutrire, ancora molti anni più tardi, un malcelato disprezzo (“roba e robaccia, che pur vuol essere curata” lo definisce, infatti in una lettera inviata a Giovan Battista de Rossi<sup>33</sup>), fin dal primo volume, pubblicato nel 1863 e riedito nel 1893, le iscrizioni su manufatti di ogni genere vengono presentate, secondo il loro contenuto, o insieme alle epigrafi monumentali o in apposite sezioni collocate alla fine di ogni volume<sup>34</sup>. E nell’ambito del *Corpus* si manifesta la prima vera svolta nello studio dell’*instrumentum*, segnata dalla pubblicazione del volume XV (*Inscriptiones urbis Romae Latinae. Instrumentum domesticum*), edito in due tomi separati, usciti rispettivamente nel 1891 e nel 1899 e curati con incredibile pazienza e acribia scientifica da Heinrich Dressel (1845-1920). Se il primo tomo dedicato ai laterizi e agli altri manufatti ceramici (*dolia, pelves, arcae, tubi, antefixa*), che spesso venivano prodotti nei medesimi impianti, appare il naturale completamento e la riorganizzazione del lavoro di Gaetano Marini<sup>35</sup> (non a caso Dressel fu uno dei curatori dell’edizione a stampa della sua opera rimasta fino ad allora inedita<sup>36</sup>), del tutto innovativo è il secondo, nel quale la *pars III* (pp. 491-701), dedicata ai “*tituli in amphoris aut signaculo impressi aut inscripti stilo vel penicillo*”, con l’aggiunta di quelli “*qui leguntur in amphorarum operculis*” e dei “*signacula qui leguntur in calce harenata qua veteres interdum amphoras obturabant*”, segna l’inizio dello studio organico, metodico e scientifico dell’epigrafia presente sulle anfore<sup>37</sup>, fino a quel momento oggetto di studi concentrati soprattutto sulle anfore greche, considerate utili per approfondire i problemi di metrologia o per elaborare liste di magistrati cittadini<sup>38</sup>, con le felici eccezioni rappresentate dagli studi di Luigi Bruzza, dedicati alle anfore del Testaccio e dell’Emporio e a quelle di Vercelli (1813-1883)<sup>39</sup>, e di George Bonsor (1855-1930), dedicati alle anfore betiche<sup>40</sup>. Dressel, infatti, non si limita a pubblicare i testi impressi, iscritti o dipinti sulle anfore - e lo fa con schede chiarissime (fig. 6), dove l’autopsia è documentata da facsimili eseguiti personalmente con grande accuratezza e perizia (*descripsi et delineavi* è la formula che usa di solito) - ma, come già aveva sostenuto in due studi

<sup>31</sup> G. MARINI, *Le iscrizioni antiche doliari pubblicate...*, p. 7; cfr. I. DI STEFANO MANZELLA, ‘Gaetano Marini...’, p.1170.

<sup>32</sup> TH. MOMMSEN, ‘Über Plan und Ausführung eines Corpus Inscriptionum Latinarum’, in A. HARNACK, *Geschichte der königlich preussischen Akademie der Wissenschaften zu Berlin*, II, Berlin 1900, pp. 522-540.

<sup>33</sup> M. BUONOCORE, *Theodor Mommsen e gli studi sul mondo antico. Dalle sue lettere conservate presso la Biblioteca Apostolica Vaticana*, Napoli 2003, p. 244.

<sup>34</sup> Sulla suddivisione dell’*instrumentum* in classi, operata dai redattori del CIL, si veda I. DI STEFANO MANZELLA, ‘Gaetano Marini...’, p. 1169.

<sup>35</sup> Fondamentali, in ogni caso, sono ancor oggi le pagine introduttive (pp. 1-12).

<sup>36</sup> Si veda sopra alla nota 28.

<sup>37</sup> J. REMESAL RODRÍGUEZ, ‘Introducción’, in J. REMESAL RODRÍGUEZ (ed.), *Epigrafía anfórica*, Barcelona 2004, p. 9.

<sup>38</sup> L. Tadorelli, *Sull’‘instrumentum domesticum...*, pp. 29-31.

<sup>39</sup> L. BRUZZA, ‘Varj oggetti antichi rinvenuti nell’Emporio romano’, *Bullettino dell’Istituto di Corrispondenza Archeologica*, vol. 5, 1872, pp. 134-145; Id., *Iscrizioni antiche vercellesi raccolte e illustrate*, Roma 1874, pp. 185-198, 207-225; come pone in risalto L. BRECCIAROLI TABORELLI, ‘Per una ricerca sul commercio nella Transpadana occidentale in età romana: ricognizione sulle anfore di «Vercellae»’, in *Atti del Convegno di studi nel centenario della morte di Luigi Bruzza*, Vercelli 1987, pp. 129-130, Luigi Bruzza, pur privilegiando l’aspetto epigrafico, non mancò, con spirito innovatore, di indagare sull’organizzazione e sul dislocamento delle officine, così come sulle vie di commercio in base alla distribuzione areale dei marchi.

<sup>40</sup> G. BONSOR, ‘Marcas de alfareros romanos’, *Memorias de la Sociedad Arqueológica de Carmona*, 1888, pp. 56-62.

precedenti, anch'essi fondamentali, dedicati ai reperti del Monte Testaccio e del Castro Pretorio<sup>41</sup>, cerca di collegare, con il supporto della *tabula II*, riservata alle “*amphorarum formas in urbe frequentiores vel peculiares*”<sup>42</sup> e ancora oggi imprescindibile strumento di riferimento, le iscrizioni alla forma del contenitore, stabilendo così la fondamentale importanza della componente tipologica e sottolineando quell'inscindibile rapporto fra supporto e testo, fra monumento e documento, che solo in anni recenti è stato evidenziato<sup>43</sup>. Scrive infatti: “*Ex his quas numero 1-6 signatae sunt certe esse vinarias, notatas numero 7-18 garum, muriam, liquamen, similia tituli inscripti docuerunt; in amphoris oris late patentis numero 21. 22 notatis videntur fuisse composita fructuum genera varia*”<sup>44</sup>.

La pubblicazione dell'*instrumentum* nei vari volumi del *Corpus* fece dunque comprendere come l'esigenza di una documentazione scientificamente corretta e, nei limiti del possibile, completa e corredata dalla classificazione dei reperti e dalle notizie riguardanti il contesto di rinvenimento, fosse la base per studi più ampi che aiutassero a meglio conoscere i molteplici aspetti del mondo romano<sup>45</sup>, come dimostrarono, in seguito, gli studi di Herbert Bloch sui laterizi marchiati e la storia edilizia di Roma, pubblicati fra il 1936 e il 1937 e ristampati nel 1947, che fin dal titolo sottolineano il loro contributo non solo all'archeologia, ma anche alla storia<sup>46</sup>, e l'importante aggiornamento di CIL, XV, 1, pubblicato nel 1947 e nel 1948<sup>47</sup>.

Tuttavia non si riuscì a superare la diffidenza, se non il pregiudizio, che circondava tale indirizzo di ricerche, un pregiudizio che portava molto spesso a confinare questo tipo di studi nell'ambito dell'antiquaria, nel senso deteriore del termine. Sopravviveva, come ai tempi di Marini<sup>48</sup>, e sopravvisse per tutta la prima metà del Novecento, l'idea di un'epigrafia delle piccole cose, di un'epigrafia “minore”, quasi umbratile e marginale rispetto alla “grande epigrafia”, quella monumentale e spesso appariscente, ricca, come sottolinea Ivan di Stefano Manzella, di spunti e suggestioni per filologi e storici e, soprattutto, utile a essere utilizzata anche in chiave ideologica e politica, come avvenne durante il Fascismo<sup>49</sup>. Di conseguenza, studiare le iscrizioni su *instrumentum* poteva sembrare adatto solo a eruditi locali o a giovani studiosi o a inesperti compilatori di cataloghi - acutamente e non senza ironia Yvon Garlan parla di materiali “qui y sont souvent réservés aux débutants et autres « marginaux »”<sup>50</sup>-, mentre sfuggiva il grande potenziale che questi documenti avevano per ricostruire quei fenomeni sui quali le fonti letterarie raramente si soffermano. A questo si aggiunge, poi, il fatto che questa grande e variegata classe di epigrafi viene chiamata, almeno a

<sup>41</sup> H. DRESSSEL, ‘Ricerche sul monte Testaccio’, *Annali dell'Istituto di Corrispondenza Archeologica*, vol. 50, 1878, pp. 118-192; Id., ‘Di un grande deposito di anfore rinvenuto nel nuovo quartiere del Castro Pretorio’, *Bullettino della Commissione Archeologica Comunale di Roma*, vol. 7, 1879, pp. 65-112.

<sup>42</sup> CIL, XV, p. 491.

<sup>43</sup> M. FEUGÈRE, ‘L'instrumentum, support d'écrit’, in M. Feugère, P.-Y. LAMBERT (edd.), *L'écriture dans la société gallo-romaine. Éléments d'une réflexion collective*, Gallia, vol. 61, 2004, pp. 53-65; si vedano anche le riflessioni di D. MANACORDA, ‘Appunti sparsi di un archeologo’, in *Il monumento iscritto come punto d'incontro tra epigrafia, archeologia, paleografia e storia* (“Scienze dell'Antichità. Storia, archeologia, antropologia”, 13), Roma 2006, p. 652.

<sup>44</sup> CIL, XV, p. 491.

<sup>45</sup> L. TABORELLI, *Sull'instrumentum domesticum...*, pp. 42-47.

<sup>46</sup> H. BLOCH, ‘I bolli laterizi e la storia edilizia romana. Contributi all'archeologia e alla storia’, *Bullettino della Commissione Archeologica Comunale di Roma*, vol. 64, 1936, pp. 141-225; vol. 65, 1937, pp. 83-187; vol. 66, 1938, pp. 61-221; poi ristampati in Id., *I bolli laterizi e la storia edilizia romana. Contributi all'archeologia e alla storia*, Roma 1947.

<sup>47</sup> H. BLOCH, ‘The Roman Brick Stamps not published in vol. XV, 1 of the Corpus Inscriptionum Latinarum, Including Indices to the Roman Brick Stamps’, *Harvard Classical Studies in Classical Philology*, vol. 46, 1947, pp. 1-128; vol. 47, 1948, pp. 1-104.

<sup>48</sup> I. DI STEFANO MANZELLA, ‘Gaetano Marini...’, pp. 1181-1182.

<sup>49</sup> *Ibidem*, p. 1181.

<sup>50</sup> Y. GARLAN, ‘La publication des timbres amphriques grecs’, in J. REMESAL RODRÍGUEZ (ed.), *Epigrafia anfórica...*, p. 11.



partire dall'Ottocento e sulla base del diritto romano, *instrumentum domesticum*<sup>51</sup>, una definizione generica e impropria, almeno credo, e certo riduttiva, come riduttivo penso che sia usare, ancora oggi, espressioni quali “epigrafia minore” o “petite épigraphie” o, ancora “inscriptions mineures” o “Kleininschriften”<sup>52</sup>. Tali definizioni, infatti, sia non pongono in giusta evidenza l'aspetto più importante di questi materiali, ovvero che si tratta di documenti scritti, e aventi, dunque, la stessa dignità delle iscrizioni lapidee o bronzee, dei papiri e delle fonti letterarie<sup>53</sup>, sia perché, la presenza dell'aggettivo *domesticum*, che sembra, erroneamente, sottolinearne la sola sfera privata, induce a sottovalutare, inconsciamente o meno, il grande potenziale informativo di queste iscrizioni nel campo della storia economica e sociale.

E questo anche se i primi decenni del secolo sono contrassegnati dall'apparizione di lavori fondamentali per la storia economica e sociale del mondo antico, nei quali i dati offerti dall'*instrumentum* sono ampiamente impiegati, come avviene nella voce dedicata all'industria e al commercio redatta da Herman Grummerus (1877-1948) per la *Real-Encyclopädie* e pubblicato nel 1916<sup>54</sup>, e, soprattutto, in *The Social and Economic History of the Roman Empire* di Mikhail Ivanovich Rostovtzeff, uscita nel 1926, e seguita, non molti anni dopo, dal 1933 al 1940, dall'opera collettanea in più volumi *An Economic Survey of the Ancient Rome*, curata da Tenney Frank (1876-1939). Basti pensare infatti alla polemica, piuttosto accesa e tutto sommato improduttiva<sup>55</sup>, fra “primitivisti” e “modernisti”<sup>56</sup>, innescata dai contributi di Moses I. Finley, in particolare da *The Ancient Economy* edita nel 1973, opera fondamentale sì, ma che privilegia le fonti letterarie a scapito, come è stato notato, della gran mole di dati offerti dalla cultura materiale<sup>57</sup>.

E in effetti, se si escludono alcuni studi, per molti aspetti pionieristici, dedicati alle anfore romane fra il 1955 e il 1975 da Nino Lamboglia, F Benoit, Maurice Henry Callender, Fausto Zevi, Paolo Baldacci, Clementina Pannella ed Ezio Buchi<sup>58</sup>, nei quali si pone in particolare risalto la loro

<sup>51</sup> Come in *Dig.*, 33, 7 e 10; cfr. A. Berger, *Encyclopedic Dictionary of Roman Law*, Philadelphia 1953, p. 505; C. SANFILIPPO, *Istituzioni di diritto romano*, 10a ed., SOVERIA MANNELLI 2002, p. 78; l'espressione, riferita ai manufatti iscritti di uso quotidiano, si diffuse soprattutto grazie ai volumi del *Corpus Inscriptionum Latinarum*.

<sup>52</sup> Si veda quanto scrive J. REMESAL RODRÍGUEZ, 'Introduzione', in J. REMESAL RODRÍGUEZ, V. PORCHEDDU, M. GARCÍA SÁNCHEZ, 'Sodales adiuuate! Il contributo dell'informatica al progresso dell'epigrafia anforaria greca', *Epigraphica*, vol. 75, 2013, p. 309.

<sup>53</sup> Di grande interesse è quanto scrive al riguardo M. FEUGÈRE, 'Plaidoyer pour la “petite épigraphie”: l'exemple de la cité de Béziers', in R. HAUSLER (ed.), *Romanisation et épigraphie. Études interdisciplinaires sur l'acculturation et l'identité dans l'Empire romain*, Montagnac 2007, pp. 139-154.

<sup>54</sup> H. GUMMERUS, *Industrie und Handeln*, in *RE*, IX,2, 1916, coll. 1281-1535.

<sup>55</sup> Si vedano al riguardo le riflessioni di S. PANCIERA, 'Un gruppo romano per lo studio dell'*instrumentum domesticum*', in W.V. HARRIS (ed.), *The Inscribed Economy. Production and Distribution in The Roman Empire in the Light of Instrumentum Domesticum*, Ann Arbor 1993, pp. 31-32 = Id., *Epigrafi, epigrafia, epigrafisti. Scritti vari editi e inediti (1956-2005) con note complementari e indici*, Roma 2006, pp. 1790-1791.

<sup>56</sup> La bibliografia al riguardo è molto vasta; fra gli ultimi studi si veda P.F. BANG, *The Roman Bazaar. A Comparative Study of Trade and Markets in a Tributary Empire*, Cambridge 2008, pp. 2-83; lo *status quaestionis* è presentato da Arnaldo Marcone in F. CARLÀ, A. MARCONE, *Economia e finanza a Roma*, Bologna 2011, pp. 11-31.

<sup>57</sup> In particolare M.W. FREDERIKSEN, 'Theory, Evidence and the Ancient Economy', *The Journal of Roman Studies*, vol. 65, 1975, pp. 164-171, in particolare le pp. 169-171 e A. CARANDINI, *Schiavi in Italia. Gli strumenti pensanti dei Romani fra tarda Repubblica e medio Impero*, Firenze 1988, *passim*. Di grande importanza sono le puntuali osservazioni di J. REMESAL RODRÍGUEZ, 'Instrumentum domesticum e storia economica: le anfore Dressel 20', *Opus*, vol. 11, 1992, pp. 105-113.

<sup>58</sup> N. LAMBOGLIA, 'Sulla cronologia delle anfore romane di età repubblicana', *Rivista di Studi Liguri*, vol. 21, 1955, pp. 241-270; F. BENOIT, 'Typologie et épigraphie amphoriques. Les marques de Sestius', *Rivista di Studi Liguri*, vol. 23, 1957, pp. 227-285; M.H. CALLENDER, *Roman Amphorae, with an Index of Stamps*, London 1965; F. ZEVİ, 'Appunti sulle anfore romane', *Archeologia Classica*, vol. 18, 1966, pp. 208-247; P. BALDACCİ, 'Alcuni aspetti dei commerci nei territori cisalpini', in *Centro Studi e Documentazione sull'Italia romana. Atti*, I, Milano 1969, pp. 7-50; C. PANNELLA, 'Ostia, Terme del Nuotatore, ambiente I, strato V, le anfore. Appunti su un gruppo di anfore caratteristiche del I secolo d.Cr.', in

utilità per la conoscenza dei fenomeni commerciali, e i contributi presentati nel convegno dedicato alle *Recherches sur les amphores romaines*, organizzato a Roma nel 1971<sup>59</sup> per approfondire “l’utilisation en histoire économique des données fournies par les amphores romaines”<sup>60</sup>, nonché la ripresa dello studio sistematico dei bolli doliari urbani, da parte della Scuola Finlandese, anche sotto l’aspetto dell’organizzazione della produzione e dell’analisi storica e prosopografica di quanti vi erano coinvolti<sup>61</sup>, indagini sviluppate poi con notevoli risultati da Eva Margareta Steinby<sup>62</sup>, fino all’importante incontro tenutosi nel 2000 a Roma<sup>63</sup>, bisogna attendere gli anni Ottanta e Novanta per assistere a una decisa ripresa delle ricerche sull’*instrumentum*. Infatti all’incontro tenutosi a Siena nel 1986, e dedicato a *Amphores romaines et historique économique*<sup>64</sup> e a quello di Udine, nel 1987, dedicato ai *Laterizi di età romana nell’area nordadriatica*<sup>65</sup>, sono seguiti i convegni tenutisi a Roma nel 1992 e dedicati rispettivamente a *The Inscribed Economy: Production and Distribution in The Roman Empire in the Light of Instrumentum Domesticum* e a *Epigrafia della produzione e della distribuzione*<sup>66</sup>, incontri che già nel titolo evidenziano, gli ultimi due in particolare, lo stretto legame esistente fra storia economica e *instrumentum* e ne sottolineano l’importanza ai fini dello studio della produzione e della distribuzione di manufatti, di merci e di derrate nel mondo romano. E, a tale riguardo, è interessante quanto scrive Silvio Panciera nella prefazione al volume degli Atti: “i nostri anni hanno visto anche una formidabile crescita d’interesse per la storia economica e sociale del mondo antico, ma l’obbligatoria collaborazione, che sembrerebbe discenderne, tra cultori di storia economica e sociale e gli studiosi (in primo luogo archeologi ed epigrafisti) dell’*instrumentum* resta ancora scarsa e non sempre soddisfacente”<sup>67</sup>. Sempre in quegli anni un convegno, tenutosi a Pécs<sup>68</sup> e accompagnato da una mostra corredata da un esauriente catalogo<sup>69</sup>, segnò finalmente il passaggio dalla definizione, riduttiva e fuorviante, come si è detto, di *instrumentum domesticum* a quella meglio circoscritta e più precisa di *instrumentum inscriptum*<sup>70</sup> e richiamò l’attenzione degli studiosi anche su numerose altre classi di oggetti iscritti, in precedenza abbastanza trascurate, come il vasellame

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*Studi Miscellanei* 16. *Ostia II*, Roma 1970, pp. 102-156; E. BUCHI, ‘Banchi di anfore romane a Verona. Note sui commerci cisalpini’, in *Il territorio veronese in età romana*, Atti del Convegno, Verona 1973, pp. 531-649.

<sup>59</sup> *Recherches sur les amphores romaines*, Colloque de Rome, Rome 1972.

<sup>60</sup> ‘Avertissement’, in *Recherches sur les amphores...*, p. 5.

<sup>61</sup> T. HELEN, *Organization of Roman Brick Production in the First and second Century A.D. An Interpretation of Roman Brick Stamps*, Helsinki 1975; P. SETÄLÄ, *Private Domini in Roman Brick Stamps of the Empire. A Historical and Prosopographical Study of Landowners in the District of Rome*, Helsinki 1977; M. STEINBY, ‘La cronologia delle figlinae doliari urbane dalla fine dell’età repubblicana fino all’inizio del III sec.’, *Bullettino della Commissione Archeologica Comunale di Roma*, vol. 84, 1974-1975 [1977], pp. 7-132; J. SUOLATHI (ed.), *Lateres signati Ostienses*, 1-2, Roma 1975-1978.

<sup>62</sup> Come M. STEINBY, ‘I senatori e l’industria laterizia urbana’, in *Epigrafia e ordine senatorio*, Atti del Colloquio Internazionale AIEGL, Roma 1982, pp. 227-237; Ead., *Indici complementari ai bolli doliari urbani (CIL, XV, 1)*, Roma 1987; Ead., ‘L’organizzazione produttiva dei laterizi: un modello interpretativo per l’*instrumentum* in genere?’, in W.V. HARRIS (ed.), *The Inscribed Economy: Production and Distribution in The Roman Empire in the Light of Instrumentum Domesticum*, Ann Arbor 1993, pp. 139-143.

<sup>63</sup> Ch. BRUUN (ed.), *Interpretare i bolli laterizi di Roma e della valle del Tevere: produzione, storia economica e topografica*, Roma 2005.

<sup>64</sup> *Amphores romaines et histoire économique: dix ans de recherches*, Actes du Colloque, Rome 1989.

<sup>65</sup> C. ZACCARIA (ed.), *I laterizi di età romana nell’area nordadriatica*, Roma 1993.

<sup>66</sup> W.V. HARRIS (ed.), *The Inscribed...; Epigrafia della produzione e della distribuzione*, Actes de la VII<sup>e</sup> Rencontre franco-italienne sur l’épigraphie du monde romain, Rome 1994.

<sup>67</sup> S. PANCIERA, ‘Prefazione’, in *Epigrafia della produzione...*, p. VI.

<sup>68</sup> M. ORMOS (ed.), *Instrumenta Inscripta Latina*, Atti del Convegno, Pécs 1992.

<sup>69</sup> *Instrumenta inscripta Latina, Das römische Leben im Spiegel der Kleininschriften. Ausstellungskatalog*, Pécs 1991; nella medesima occasione si allestì, sempre sullo stesso tema, un’esposizione ad Aquileia: F. MASELLI SCOTTI, C. ZACCARIA, *Instrumenta Inscripta Latina. Sezione aquileiese*, Aquileia 1992.

<sup>70</sup> M. HAINZMANN, Z. VISY, ‘Vorwort’, in M. ORMOS (ed.), *Instrumenta Inscripta Latina...*, pp. 3-4.

bronzeo, i *pondera*, i pesi da telaio, la ceramica comune, le etichette di piombo, i *signacula*, le armi e l'equipaggiamento militare<sup>71</sup>.

La fine degli anni Settanta e gli anni Ottanta sono caratterizzati anche dalla ripresa degli studi sulle anfore del monte Testaccio da parte di Emilio Rodríguez Almeida prima<sup>72</sup> e di José María Blázquez Martínez con José Remesal Rodríguez poi<sup>73</sup>. E sono soprattutto gli studi su queste anfore a dimostrare, diversamente dallo scetticismo mostrato da Moses I. Finley verso le fonti archeologiche<sup>74</sup>, quali fruttuosi percorsi di ricerca si possono intraprendere nel campo della storia economica e sociale del mondo antico<sup>75</sup>, spesso con risultati che sovvertono tesi consolidate o aprono prospettive inaspettate. Basti pensare ai progressi compiuti nell'ambito della conoscenza dell'organizzazione e dell'evoluzione della politica annonaria durante l'impero romano o del commercio dell'olio della *Betica* (e non solo della *Betica*) in *Britannia*<sup>76</sup> o, ancora, l'organizzazione dell'annona militare in Germania<sup>77</sup>. E l'analisi dell'epigrafia di queste anfore può anche aiutare a meglio comprendere alcuni passi delle fonti letterarie, come la *Historia Augusta*<sup>78</sup>, o a cogliere con maggiore precisione i cambiamenti amministrativi operati da Settimio Severo<sup>79</sup>.

Ormai definitivamente provata l'importanza dell'*instrumentum inscriptum* come fonte indispensabile per la ricostruzione dei fenomeni storici<sup>80</sup>, negli ultimi decenni gli sforzi degli studiosi si sono orientati verso la creazione di strumenti informatici, soprattutto di banche dati, che permettano di archiviare e di consultare grandi quantità di dati inediti oppure editi, ma spesso con errate letture e con una pessima documentazione grafica e fotografica, in miriadi di pubblicazioni, talora difficilmente reperibili<sup>81</sup>. Hanno preso così vita progetti come *Testimonia Epigraphica Norica*

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<sup>71</sup> Al primo incontro ne sono seguiti altri a Klagenfurt nel 2005 (M. HAINZMANN, R. WEDENIG (edd.), *Instrumenta inscripta Latina II*, Klagenfurt 2008), a Macerata nel 2009 (G. BARATTA, S.M. MARENGO (edd.), *Instrumenta inscripta III. Manufatti iscritti e vita dei santuari in età romana*, Macerata 2012), a Barcellona nel 2011 (G. BARATTA (ed.), *Instrumenta inscripta IV. Nulla dies sine littera. La scrittura quotidiana in la casa romana*, SEBarc, vol. 10, 2012, pp. 8-447), a Verona nel 2012 (A. BUONOPANE, S. BRAITO (edd.), *Instrumenta inscripta V. Signacula ex aere. Aspetti epigrafici, archeologici, giuridici, prosopografici, collezionistici*, Roma 2014) e ad Aquileia nel 2015 (M. BUORA, S. MAGNANI (edd.), *Instrumenta inscripta VI. Le iscrizioni con funzione didascalico-esplicativa*, Trieste 2016).

<sup>72</sup> Dei molti lavori dedicati all'argomento mi limito a segnalare E. RODRÍGUEZ ALMEIDA, 'Bolli anforari del monte Testaccio. I', *Bullettino della Commissione Archeologica Comunale di Roma*, vol. 84, 1975-1976, pp. 199-248; Id., 'Bolli anforari del monte Testaccio. II', *Bullettino della Commissione Archeologica Comunale di Roma*, vol. 86, 1977-1978, pp. 107-137; Id., *Il monte Testaccio. Ambiente, storia, materiali*, Roma 1984.

<sup>73</sup> La bibliografia è amplissima, per cui rimando ai sei volumi di contributi finora pubblicati: J.M. BLÁZQUEZ MARTÍNEZ, J. REMESAL RODRÍGUEZ (edd.), *Estudios sobre el Monte Testaccio (Roma)*, I, Barcelona 1999; II, Barcelona 2001; III, Barcelona 2003; IV, Barcelona 2007; V, Barcelona 2010; VI, Barcelona 2014, ove è possibile reperire tutta la letteratura precedente. Si consulti anche <http://ceipac.ub.edu>.

<sup>74</sup> Si veda sopra alla nota 57.

<sup>75</sup> Si veda quanto scrive J. REMESAL RODRÍGUEZ, 'Instrumentum domesticum...', p. 105.

<sup>76</sup> C. CARRERAS MONFORT, P.P. A. FUNARI, *Britannia y el Mediterráneo: estudios sobre el abastecimiento de aceite bético y africano en Britannia*, Barcelona 1998; si veda anche Id., 'The Role of the Instrumenta Inscripta Latina in discussing the Roman Economy: Britain as Case of Study', in M. HAINZMANN, R. WEDENIG (edd.), *Instrumenta inscripta Latina II...*, pp. 107-117.

<sup>77</sup> J. REMESAL RODRÍGUEZ, *La annona militaris y la exportación de aceite bético a Germania*, Madrid 1986.

<sup>78</sup> J. REMESAL RODRÍGUEZ, 'Escrito en barro: el monte Testaccio y la Historia Augusta', in G. BONAMENTE, M. MAYER (edd.), *Historiae Augustae colloquium Barcinonense*, Bari, 2005, pp. 249-256.

<sup>79</sup> J. REMESAL RODRÍGUEZ, 'Transformaciones en la exportación del aceite bético a mediados del siglo III d.C.', in J.M. BLÁZQUEZ MARTÍNEZ (ed.), *Producción y comercio del aceite en la antigüedad*, Segundo Congreso Internacional, Madrid 1983, pp. 115-131.

<sup>80</sup> Significativo è il contributo di G. PUCCI, 'Inscribed Instrumentum', in J. BODEL (ed.), *Epigraphic Evidence. Ancient History from Inscriptions*, London and New-York 2001, pp. 137-152.

<sup>81</sup> Come sostiene giustamente Yvon Garlan, che, riferendosi ai marchi greci su anfore, aggiunge che a suo parere solo un decimo del materiale rinvenuto sia stato pubblicato: Y. Garlan, 'La publication des timbres amphoriques...', p. 12; sui

(T.E.NOR), *Roman amphorae: a digital resource*, *Lateres: opus doliare signatum* e, soprattutto, il Database “*Corpus Ceipac*” - *Corpus informático del instrumentum domesticum*, patrocinato dal Centro para el Estudio de la Interdependencia Provincial en la Antigüedad Clásica del Departement de Prehistòria, Història Antigua y Arqueologia dell’Università di Barcelona, che online dal 7 settembre 1995, con le sue oltre 41.000 schede dettagliatamente articolate<sup>82</sup> (fig. 7), è uno strumento di base per ogni ricercatore, come dimostra l’alto numero di visite e di accessi<sup>83</sup>. A questo si deve inoltre aggiungere il fatto che anche alcune delle banche dati originariamente nate con lo scopo di raccogliere solo le iscrizioni monumentali, come l’*Epigraphische Datenbank Heidelberg* (EDH), l’*Epigraphic Database Roma* (EDR) e l’*Epigraphische Datenbank Clauss-Slaby* (EDCS), cominciano a inserire anche testimonianze di *instrumentum inscriptum*, sia pure in maniera non sistematica e privilegiando soprattutto il testo iscritto rispetto al supporto.

La potenzialità di questi strumenti è enorme, come hanno più volte sottolineato J. Remesal Rodríguez, Claudio Zaccaria e Manfred Hainzmann<sup>84</sup>: le banche dati non consentono solo di identificare i luoghi di produzione, le modalità e le vie della distribuzione e i centri di consumo, ma permettono anche, incrociando i loro dati con quelli offerti da altre risorse, cartacee o elettroniche, di identificare personaggi (proprietari di *fundi* e/o di *figlinae*, produttori, trasportatori, commercianti), di individuare l’eventuale coinvolgimento di gruppi familiari o di appartenenti alle varie élites cittadine o statali, di ricostruire l’articolazione dei processi produttivi grazie all’analisi degli elementi forniti dall’onomastica e dall’indicazione dello stato giuridico.

Le “piccole” iscrizioni, dunque, sono cresciute<sup>85</sup> e sono diventate “grandi”: da oggetti curiosi, degni solo di essere esposti in qualche *wunderkammer*, sono divenute strumenti imprescindibili di studio e di conoscenza, dimostrando che “elevare alla categoria di «fonte storica» un documento archeologico capace di darci informazioni sull’economia, la società e la politica del mondo antico, non è un compito facile”<sup>86</sup>, ma è, tuttavia, un compito possibile.

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problemi legati alla pubblicazione dell’*instrumentum inscriptum*: A. BUONOPANE, ‘La pubblicazione di marchi e di graffiti su *instrumentum inscriptum*: alcune riflessioni’, in M. BUORA (ed.), *Ceramica a vernice nera e terra sigillata norditalica da Aquileia. Recenti indagini e confronti regionali*, Atti del Convegno, Trieste 2012, pp. 11-16.

<sup>82</sup> Per la struttura del database si veda J. REMESAL RODRÍGUEZ, P. BERNI MILLET, A. AGUILERA MARTÍN, ‘*Amphoreninschriften und ihren elektronische Bearbeitung*’, in M. HAINZMANN, R. WEDENIG (edd.), *Instrumenta inscripta Latina II...*, pp. 247-264.

<sup>83</sup> Nel 2015 i visitatori sono stati oltre 110.000 e gli accessi quasi 3.000.000. Ringrazio José Remesal Rodríguez che mi ha cortesemente comunicato questi dati.

<sup>84</sup> J. REMESAL RODRÍGUEZ, P. BERNI MILLET, A. AGUILERA MARTÍN, ‘*Amphoreninschriften und ihren elektronische Bearbeitung...*’, pp. 247-264; C. ZACCARIA, ‘*Instrumenta inscripta Latina: potenziale informativo e importanza dei corpora elettronici. Alcuni esempi dalla Regio X orientale*’, *Ibidem*, pp. 347-368; J. REMESAL RODRÍGUEZ, ‘Introduzione...’, pp. 309-311; M. HAINZMANN, ‘*Amphoreninschriften aus Noricum. Neues zum Projekt T.E.NOR*’, in J. REMESAL RODRÍGUEZ (ed.), *Epigrafia anfórica...*, pp. 89-104.

<sup>85</sup> Traggo l’espressione da C. ZACCARIA, ‘Piccole iscrizioni crescono. Le potenzialità di una banca dati epigrafica integrata con le scritte su *instrumentum* per la storia economica e sociale della Regio Decima’, in P. BASSO, A. BUONOPANE, A. CAVARZERE, S. PESAVENTO MATTIOLI (edd.), ‘*Est enim ille flos Italiae...*’. *Vita economica e sociale nella Cisalpina romana*, Atti delle giornate di studio in onore di Ezio Buchi, Verona 2008, pp. 369-383.


<sup>86</sup> J. REMESAL RODRÍGUEZ, ‘Introduzione...’, p. 309.



Pag. CLXXXIV. OPERVM ET LOCORVM

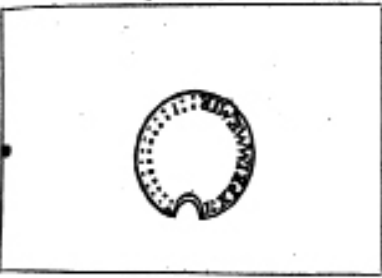
**1** *Romae in sigillo figlinae antiquae.*  
OPVS. DOL. Q. NONI PRISCIANI  
M. COMMOD. AVG. VII. HEL. PERTIN. II. COS  
\* A. V. 247.

*Però figlinae hae quadrati lateres sunt, sesquipedem undique lati & sesquidigittum craffi: aliquando etiam paulo minores, aut oblongiores: habentque ferè impressum sigillum, quod intra circulos suos, ad modum nominatum inscriptum est.*  
*Faciem hic utroque reperisse hacten.*



**2** *In antiqua figlina.*  
EX. PRIVATA. L. SERVILI. FORTVNATI. MACEDON  
T. STATILI. MVNERI  
NERO. CLAVDIVS. CAES. L. ANTIISTI  
VS. VETVS. COS  
*Ex Faustili Follia.*

**3** *Figlina alia antiqua cum hoc sigillo & literis palatib. in monte Quirinali reperta.*



*Quirinali reperta.*

**4** *Saxa Tiburtina venerandas antiquitatis à fœderis Clusae maximae in foro Rom. quae à posterioribus sine ordine collecta erant, nuper diruta. nōi autem prius steterint, non constat.*

Q. FABIVS.	Q. F. MAXVMVS	AED.	CVR. RES
Q. FABIV	F. MAXSV		CVR. RE

*maxima videri.*

**5** *Romae ad radices Caesii montis aliquot Tiburtini lapides inventi, cum hac inscriptione.*  
\* TL IVLIO. CANDIDO. II. A. IVLIO. QVADRATO. II. COS  
*Ex Fabio Prædici.*  
\* A. Urb. 577. vid. CIL. I. 2. 1. 2.

**6** *Reperunt Maritanis & Favanti, Romae ex ruinis, quas nunc sepimus ad eam D. Silvestri, extraxit etiam craffissimae lapides quadratos, quorum aliqui habentur haec verba.*

DOMITIANA MAIOR  
PARS


**7** *Aliqui.*

DOMITIANA MINOR.


**11** *Romae tegulae quaedam his literis inscriptae.*  
TEG. C. COSCONI  
FIG. ASINI. POLL  
*Ex Bulligianis.*

**12** *Favanti in ambulo arcae, quae apud Frieder. Conarum Praetorem D. Marci.*  
APIETHIANX APIXTOKAIOYE  
MTTPINOTIIOE  
*Signum Vellies.*

**8** *Ad Viciniam Alabrog. in pago vulgo dicitur Leyre, prope Sanctum Romanum huiusmodi tegulae repertae.*



*Item tales.*




*Quatuor à Vedulii Schedis.*

**9** *Zabern inscriptum arcae.*

FAVSTVS  
FECIT


*Ex Aplano.*

**10** *Tegula reperta Offiae, cuius sigillo inscribitur.*



*Quatuor à m. Schedis.*

**12** *Favanti non procul à Florentia, tegula inventa forma circuli, sic inscripta.*



*Ex Regium Dialogis.*  
\* A. 576. Vnde inscribitur ad PACTUM & APFON COS. inf. ALBERTA. in. Gual. non fons APR. in. Gual. Coll. Q. Arria Vianone & C. Vindidius Agronon Gual. p. 7

Fig. 1. L'instrumentum inscriptum in una pagina della silloge di Jan Gruter (J. Gruter, *Inscriptiones antiquae totius orbis Romani in absolutissimum corpus redactae*, Amstelædami 1602, p. CLXXXIV).

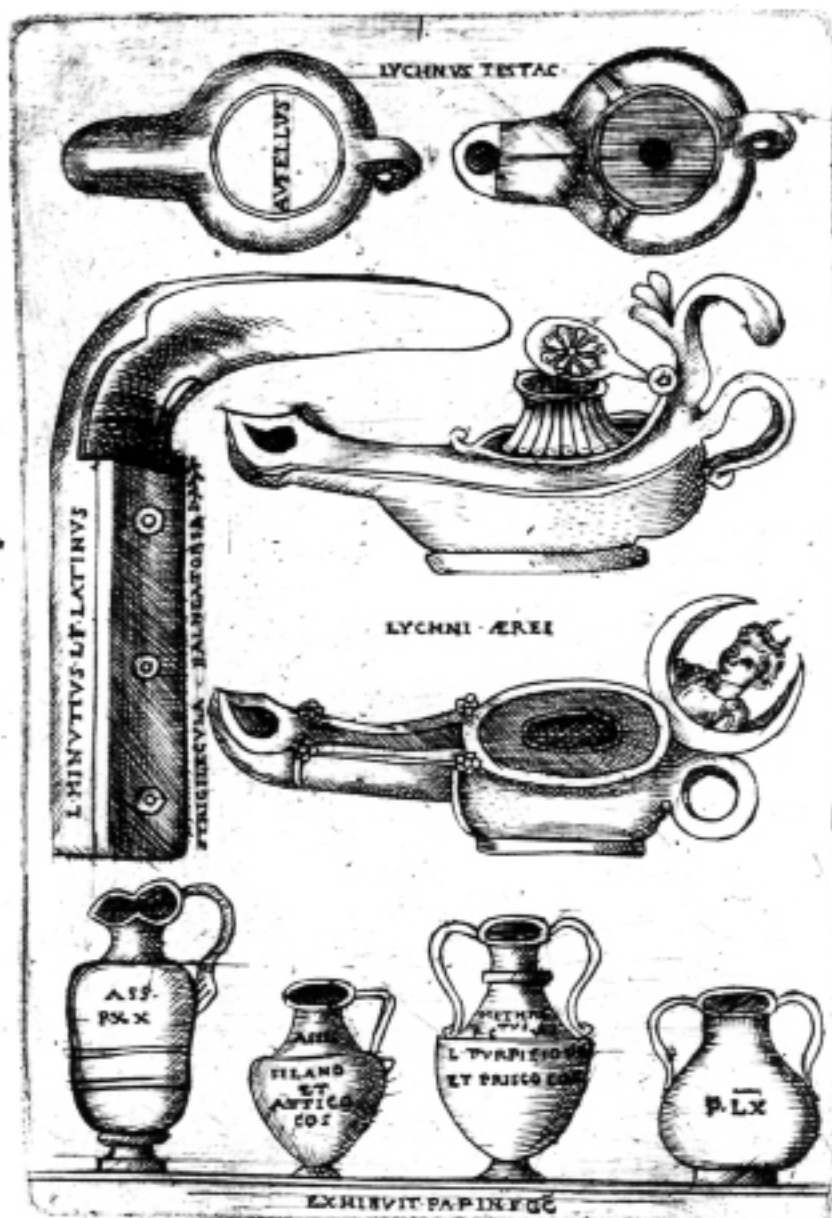


Fig. 2. Uno strigile, lucerne e vasellame bronzeo iscritto in una raccolta del Seicento (P. Pétau, *Antiquariae supellectilis portiuncula*, Parisii 1610, tav. 16).

## Libro Primo:

55

incenerito. il medesimo par, che accenni anco il Pignoria nelle sue Ori-  
gini di Padua, mentre ragiona della positura della medesima Città, fuo-  
ra di quel circuito, il qual stima esser il vecchio, fa accadere i luoghi de i  
sepolcri, che anticamente si chiamauano *Particulae*. E medesimamente  
fuori di quelle mura vecchie, afferma hauer veduto nel cauar fondamen-  
ti di alcune fabbriche, riuouarsi quantità grande di Vrne sepolcrali, come  
anco in tal luogo il sepolcro di Tito Liuius: e, per quanto dice Plinio, <sup>Lib. 2. cap. 54</sup>  
quelli, che perivano di fætta, non si dauano in preda al fuoco, per vn  
istinto di religione, mà si seppelliuano interi. Mà appresso de' Romani  
restò tal costume d'abbruciar i cadaveri, sino al tempo de' gli Antoni-  
ni, come riferisce il Porcacchi. E perche hò detto, che al coperto di vna <sup>Fig. 5.</sup>  
delle antedette Vrne vi sono alcune lettere (come dalla qui posta figura  
si vede) le quali contengono il nome dell'incenerito, come anco quello  
del padre, per quanto hà potuto con non minor dottrina, che eleganza  
spiegare l'Eccellentissimo Fortunio Liceto singolarissimo, per la pienissi-  
ma cognitione delle cose antiche: così da me ricercato, e da esso con  
gentilissima cortesia fauorito.



CLAR. VIRO LVDOVICO MOSCARDO VERONENSI

Fortunius Licetus B. A.

**A** Deò tenebricosum sensum habent illæ tres & decem literæ disci tæctæ  
circularis ambitum adornantes, pro maiori parte continuatæ, & pun-  
ctis interstinctæ, ut diuinatore potius indigeant, quàm interpretis cruditione,  
qui claræ, & integram sententiam ex illis elicere valeat. Vtinam mihi  
liceat in illis quæ nunc explicandis Tibi satisfacere. Censui literas esse singu-  
las capitales integrorum dictionum: quæ inter se constructim non admitte-

rs

Fig. 3. Un operculum in una collezione del Seicento (L. Moscardo, *Note overo memorie del Museo di Lodovico Moscardo nobile veronese*, Padova 1656, pp. 55).



Fig. 4. Tre bolli doliari urbani nel corpus di Scipione Maffei (S. Maffei, *Museum Veronense, hoc est antiquarum inscriptionum atque anaglyphorum collectio...et ubicumque collecta*, Veronae 1749, p. CXI).



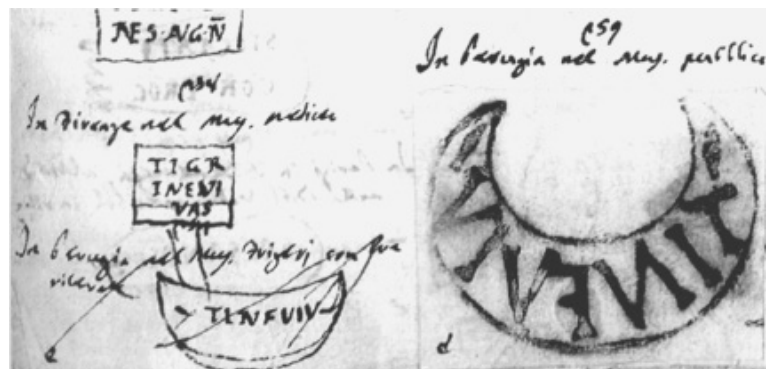
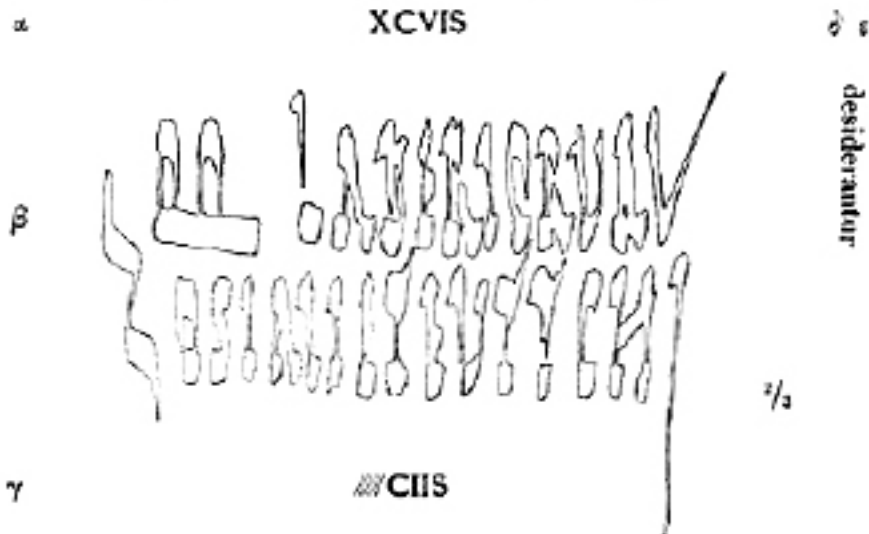


Fig. 5. Il calco di un signaculum (CIL, XI, 6713, 43) nel manoscritto di Gaetano Marini (G. Marini, *Le iscrizioni antiche doliari con note. Alle quali si danno per giunta quelle de' Sigilli di Bronzo e degli Acquedotti di piombo*, Cod. Vat. Lat. 9110, p. 172, nr. 259, da I. Di Stefano Manzella, 'Gaetano Marini...', p. 1185, fig. 6).

**3922** Testaccio, forma litt. C [repos. urb. (D 650)].



Descripsi et delineavi. —  $\beta$ : QQ. Laberiorum Zosimi et Eutycki. —  $\gamma$  videtur fuisse CCHS.

Fig. 6. Un *titulus pictus* su un'anfora del monte Testaccio in una scheda di Heinrich Dressel (CIL, XV, 3922).

ceipac.gh.ub.es/corpus/call.php?buonopane=65408f2beb6091956318fee75562f54a&COM=a2xNQUBPT0jWGE

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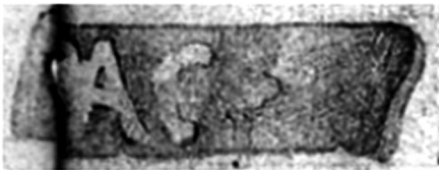
**CEIPAC n° 9677**

[notify errors] [export data] [+ list] [help]

Typology: Amphora incerta  
Find place: **Stazione Ferroviaria (Padova, Italy), Carta Archeologica n.3**  
Conservation place: Mus. Civico  
Dating: -  
Observations: -

Literature:  
0379 [C] PESAVENTO MATTIOLI S., MAZZOCCHIN S. (1992). **Appendize 2. I Bolli e i graffiti delle anfore della Stazione Ferroviaria.** S. Pesavento (Ed.) Anfore Romane a Padova. Ritrovamenti della città, Modena, pp. 175-185; n° 35, tav.27, n.43.

Stamp : PACCI  
Conservation: |PAC+|  
Location: in collaris  
Direction: Directa  
Relief: litt. extantibus  
Observations: PESAVENTO & MAZZOCCHIN (1992): PAC[CI]



This epigraphic file must be cited on a publication only as : CEIPAC 9677

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Fig. 7. Una scheda dedicata al marchio PACCI nella banca dati del CEIPAC.

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## GLI SCAVI A TESTACCIO: PORTO FLUVIALE, *PORTICUS AEMILA*, *HORREA*, MONTE TESTACCIO

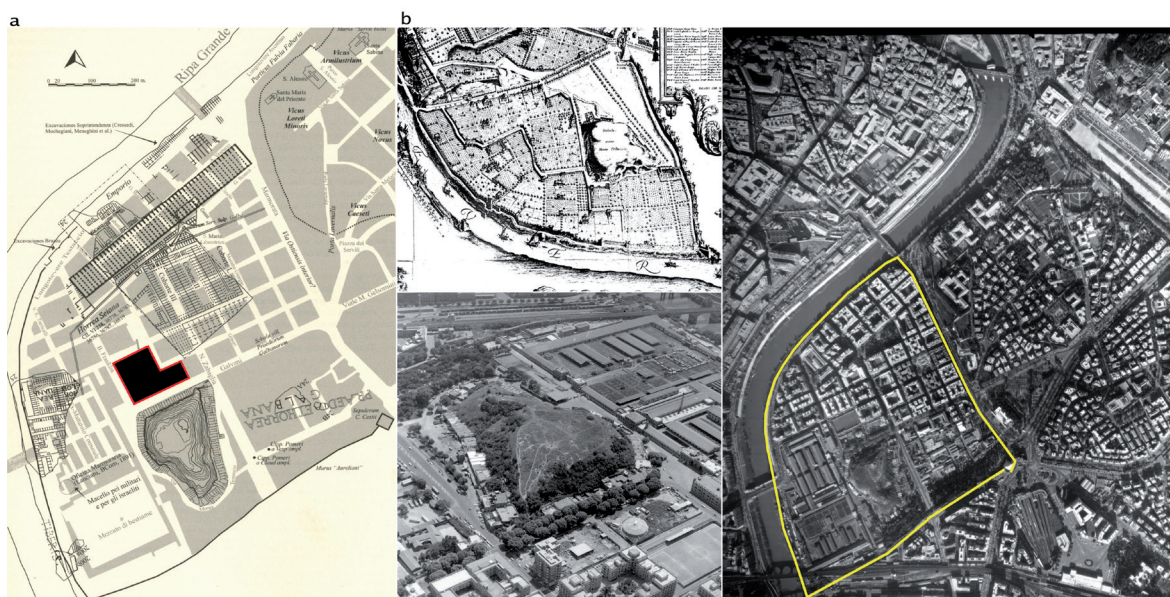
RENATO SEBASTIANI

SOPRINTENDENZA SPECIALE PER IL COLOSSEO E L'AREA ARCHEOLOGICA CENTRALE DI ROMA

La porzione di pianura alluvionale ai piedi del colle Aventino (piana subaventina), detta di Testaccio dal rione (termine che a Roma indica i quartieri storici centrali della città) costruito a cavallo tra il XIX e il XX secolo che dal Monte Testaccio prende il suo nome, si estende per circa 600.000 mq, sulla riva sinistra del Tevere, nella parte sud-ovest della città di Roma (fig. 1a-d)

Si tratta di un territorio sub rettangolare, i cui limiti sono definiti da elementi sia naturali sia antropici. I primi sono l'ansa del Tevere a nordovest e a ovest e le pendici dell'Aventino a nordest e a est, mentre le Mura Aureliane, nel tratto tra Porta S. Paolo, l'antica Porta Ostiense, e il fiume, ne segnano, dall'ultimo quarto del III secolo d.C. il confine sudorientale e meridionale. L'ambiente naturale in epoca storica, almeno a partire dalla prima urbanizzazione di età repubblicana, ha subito profondi mutamenti legati all'insediamento antropico. La continua evoluzione del paesaggio fluviale e della piana alluvionale nel corso dei secoli, può essere per grandi e necessariamente sommarie linee, definita nella successione di tre "macro paesaggi": quartiere infrastrutturale, porto e principale "area logistica" della città antica, dall'inizio del secondo secolo a.C. per tutto il periodo repubblicano e imperiale, campagna suburbana dal Medioevo alla fine del XIX secolo, nuovamente quartiere cittadino quando, dopo il 1870, torna alla sua origine urbana, con la costruzione del rione popolare della città appena divenuta capitale del giovane Regno d'Italia. Esempi materiali rilevanti dei tre differenti paesaggi succedutisi nel corso dei millenni, sono oggi visibili nel tessuto urbano contemporaneo (fig. 2 a, b, c).





**Fig. 1. a) La pianura subaventina in età romana, evidenziata l'area dello scavo del Nuovo Mercato Testaccio (Aguilera Martín, 2002) – b) Pianta di Roma di G. Falda del 1676, particolare dell'area di Testaccio – c) Monte Testaccio. Veduta aerea. Collezione Aronson 291 (1979). Photographic Archive of American Academy in Rome - d) Rione Testaccio e colle Aventino. Veduta aerea. Foto Ikonos (1998).**



**Fig. 2a. Mura aureliane (foto SSBAR) – Piramide Cestia (foto SSBAR) – Monte Testaccio. Saggio archeologico (per gentile concessione Prof. J. Remesal Rodríguez-CEIPAC).**

Roma è stata nel passato per secoli una città enorme. Capitale di un impero multietnico, questa megalopoli era il centro politico e il motore di un mercato, che oggi chiameremmo globale, esteso oltre gli stessi confini politico militari dell'impero romano. Il bacino del Mediterraneo era al centro di questo immenso territorio e dei suoi traffici commerciali.

Il trasporto via acqua, mare e acque interne (laghi e fiumi) era il sistema più efficiente ed economico di movimentazione delle merci. Una complessa rete di rotte e scali portuali ha assicurato per secoli il trasporto sia a lunga distanza sia regionale di ogni tipo di merci. Le navi, le grandi

onerarie come i diversi modelli di imbarcazioni fluviali, collegavano Roma e le innumerevoli città dell'impero tra loro e con molti scali oltre i confini, garantendo il trasporto di grano, olio, vino, *garum*, spezie ma anche legno, metalli, marmo e altre pietre, tessuti, sostanze coloranti, ambra, manifatture, ecc.

Tutto questo portò in età romana ad un grande sviluppo della tecnologia navale, con molti tipi di imbarcazioni per la navigazione marittima e per quella fluviale e lacustre, e allo stesso tempo della tecnologia delle infrastrutture portuali e dei sistemi logistici per la movimentazione, lo stoccaggio delle merci e lo smaltimento dei rifiuti ad essi legati.

Una delle maggiori conseguenze dell'espansione romana nel Mediterraneo occidentale all'inizio del II secolo a.C. e in tutto il bacino nei successivi due secoli, fu la crescita esponenziale demografica e territoriale della città di Roma, che nei primi decenni dell'impero doveva aggirarsi intorno al milione di abitanti. Senza entrare nel complesso terreno della demografia antica, interessa qui sottolineare che l'approvvigionamento di una città così grande deve aver costituito una sfida eccezionale a cui i governanti romani hanno risposto con soluzioni logistiche assai complesse.

Tra la fine del III e l'inizio del II secolo a.C. due porti servivano direttamente la città di Roma: Ostia come scalo marittimo alla foce del Tevere e il *Portus Tiberinus* interno, sul fiume, all'altezza del Foro Boario, subito a valle dell'Isola Tiberina. Il Tevere stesso fungeva da via principale di movimento delle persone e delle merci attraverso le imbarcazioni fluviali, le navi *caudicarie*, che risalivano la corrente attraverso l'alaggio dalle rive.

Questo sistema di infrastrutture portuali, dopo la fine della Seconda Guerra Punica, era insufficiente all'approvvigionamento di Roma e della sua crescente popolazione.

I limiti di Ostia come porto marittimo, dovuti alla tendenza all'insabbiamento della foce del Tevere e alla scarsa capacità delle banchine d'attracco, fino alla prima età imperiale vennero solo parzialmente affrontati con il potenziamento di *Puteoli* (Pozzuoli) nel Golfo di Napoli, porto efficiente anche se troppo lontano da Roma. Solo con il gigantesco progetto di Claudio, avviato nel 42 d.C., di costruzione di un nuovo scalo marittimo, *Portus*, poco a nord di Ostia, nell'attuale area di Fiumicino, la città verrà dotata di un porto marittimo adeguato alle sue necessità, che funzionerà per quasi cinque secoli.

L'insufficiente capacità del *Portus Tiberinus* venne invece risolta molto prima, all'inizio del II secolo a.C., con la costruzione del nuovo porto interno della città sulla riva sinistra del fiume ai piedi dell'Aventino, subito fuori delle mura serviane.

Prima porzione di pianura alluvionale fuori della città antica, la piana subaventina è compresa in un'ansa del Tevere favorevole all'approdo. Questi elementi furono probabilmente decisivi nella scelta di costruirvi il nuovo porto fluviale della città quando Roma ebbe bisogno di ampliare le proprie infrastrutture portuali interne. Al 193 a.C., secondo Livio risale la prima costruzione dell'*emporium* e di un grande edificio contiguo citato come *Porticus Aemilia*. Sempre secondo Livio queste strutture furono completate nel 174 a.C.<sup>1</sup>

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<sup>1</sup> “*porticum unam extra portam trigeminam (fecerunt) emporio ad tiberim adiecto* (Liv. 35.10.12); “*extram portam trigeminam emporium lapide straverunt stipitibusque saepserunt et porticum aemiliam reficiendam curarunt, gradibusque ascensum a tiberi in emporio fecerunt*” (Liv. 41.27.8)

A seguire la realizzazione, plausibilmente di natura pubblica, di queste infrastrutture, gran parte della piana di Testaccio fu urbanizzata secondo le necessità dello stoccaggio delle merci e della loro commercializzazione e distribuzione, arrivando a costituire la principale area logistica della città. Le banchine portuali estese lungo il fiume oltre le strutture oggi visibili all'inizio del lungotevere Testaccio, i grandi *horrea* (*Galbana, Lolliana e Seiana*) insieme probabilmente a insediamenti artigianali e di commercio, divennero progressivamente il tratto tipico di questo paesaggio urbano (fig. 1a). La discarica imperiale del Monte Testaccio, popolarmente chiamato in età moderna “Monte dei Cocci” costituirà non solo un elemento progressivamente sempre più visibile e importante del “quartiere portuale” e del paesaggio antico, ma diventerà un elemento centrale forte e di continuità nel tempo del paesaggio subaventino, dall'età antica a quella medievale e moderna (figg. 1c; 2 a). La collina artificiale, alta più di 30 metri sulla piana circostante, perderà nei secoli aspetto e memoria di discarica per “naturalizzarsi” e assumere nuove funzioni. Esempio unico di archivio materiale dei commerci imperiali, di colonizzazione vegetazionale recente, di luogo simbolico deputato ai festeggiamenti del carnevale medievale e alle celebrazioni pasquali della settimana santa, di bastione “naturale” di difesa della città, di magazzino per il vino nelle “grotte” realizzate ai suoi piedi nel XVII secolo, divenute oggi sede di una delle maggiori concentrazioni di locali notturni della città, il Monte Testaccio, è realmente un monumento di valore storico e ambientale unico a Roma<sup>2</sup>.

In età antica e tardo antica, l'area subaventina, con le sue strutture di ricezione e di stoccaggio delle riserve alimentari e più in generale delle merci, era ancora di importanza nevralgica per la sopravvivenza cittadina, tanto che fu inclusa nel recinto delle Mura Aureliane, realizzate tra il 272 e il 279 d.C. (fig. 2a)

Tra il V e il VII sec. d. C. il ridimensionamento delle strutture portuali e commerciali portò a un cambiamento funzionale e alla trasformazione dell'insediamento antropico, con la progressiva ruralizzazione di questa parte della città. Il territorio fu destinato all'impianto di orti e vigne che obliarono progressivamente i resti delle strutture antiche, ed entrò per un lungo periodo a far parte delle proprietà ecclesiastiche dei monasteri di Santa Maria e Sant'Alessio all'Aventino. Una vasta area tra il Monte Testaccio e le mura, in parte forse corrispondente agli antichi *proedia galbana*, rimase destinata al pubblico godimento prendendo il nome di “prati del popolo romano” (fig. 2b).

Tutti questi elementi rendono Testaccio un luogo privilegiato per leggere la storia economica della città antica: dal porto fluviale alla discarica dell'Annona, passando per la *Porticus Aemilia* e i magazzini, in poche centinaia di metri si trovano concentrati i resti materiali di questa storia.

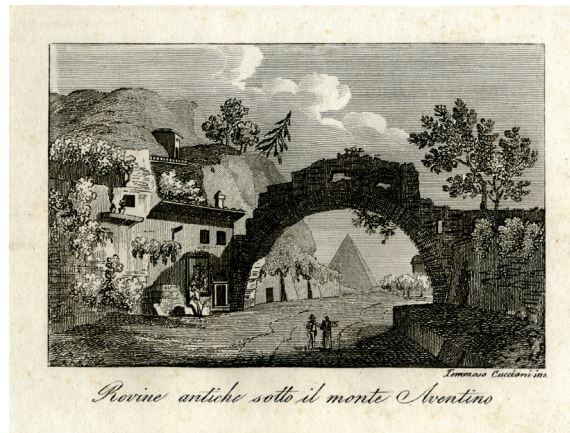
La tradizione pluridecennale di ricerche spagnole sul Monte Testaccio, partita con gli studi di E. Rodríguez Almeida, e proseguita con gli eccezionali risultati delle lunghe e articolate ricerche di J. M. Blázquez e J. Remesal Rodríguez, hanno non solo il merito di aver aiutato a capire la complessa storia nel corso dei secoli di questo “monumento”<sup>3</sup>, ma sono anche un contributo fondamentale allo studio dell'evoluzione di un settore cittadino che ha avuto, in forme diverse nel corso del tempo, un ruolo economico fondamentale per la città e per il rapporto tra questa, il Tevere e il mare, cui Roma, nonostante la relativa distanza, è strettamente legata fin dall'inizio della sua storia urbana.

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<sup>2</sup> La letteratura su Monte Testaccio è piuttosto ampia, vedi Ramieri 2007.

<sup>3</sup> Per la bibliografia relativa vedi Rodríguez Almeida 1984, Aguilera Martín 2002, Blázquez Martínez, Remesal Rodríguez 1999, 2001, 2003, 2007, 2010; 2014; Remesal Rodríguez 2016.





**Fig. 2b0**Arco di San Lazzaro. Incisione di Tommaso Cuccioni. Metà XIX secolo (Archivio SSBAR) – Cimitero acattolico (foto SSBAR) – Pianta di Roma di F. Pacioti del 1557, particolare dell'area di Testaccio.

Agli studi sul monte Testaccio, per i quali si rimanda alla ricchissima bibliografia che accompagna le ricerche dell'équipe coordinata da J. Remesal Rodriguez, si affiancano A Testaccio altri due filoni di ricerca: quello sul porto fluviale e quello sugli *horrea* e sulla cd. *Porticus Aemila*.

Il porto fluviale, l'*emporium*, è stato indagato fin dalla seconda metà del XIX secolo da padre Bruzza a cui si devono i primi scavi sistematici<sup>4</sup>; Le ricerche sono state riprese e continuate nel secondo dopoguerra<sup>5</sup>, nella prima metà degli anni '80 del secolo scorso con gli importanti lavori di Moccheggiani e Meneghini del 1979-1985<sup>6</sup> ed oggi con le nuove ricerche in corso, iniziate da P. Di Manzano e proseguite con il coordinamento di chi scrive<sup>7</sup>.



**Fig. 2c0 Edificio del Rione Testaccio, p.zza S. M. Liberatrice (foto SSBAR) – Edificio delle Poste di A. Libera, via marmorata (foto SSBAR) – Caserma dei Vigili del Fuoco, l.go M. Gelsomini (foto SSBAR) – Ex Mattatoio, padiglione interno (foto SSBAR).**

<sup>4</sup> Bruzza 1877

<sup>5</sup> Cressedi 1949-1951; 1956

<sup>6</sup> Meneghini 1985, Meneghini, Moccheggiani Carpano, 1985, Moccheggiani Carpano 1984, Moccheggiani Carpano 1995

<sup>7</sup> Per gli ultimi aggiornamenti sulle ricerche al porto fluviale vedi Contino A., D'Alessandro L., Patella E., Sebastiani R., " *L'infrastruttura portuale urbana di Roma: emporium e Porticus Aemilia alla luce dei recenti scavi*, sessione 14. PORT SYSTEMS IN THE ROMAN MEDITERRANEAN Organised by: Simon Keay and Pascal Arnaud, ROMAN ARCHAEOLOGY CONFERENCE 12, 16-19 marzo 2016



Gli studi sui magazzini, gli *horrea*, che dovevano costituire la parte principale del tessuto urbano antico nella piana subaventina alle spalle del porto fluviale, sono stati a lungo incentrati nella ricostruzione topografica dei frammenti marmorei della *Forma Urbis* severiana, nella interpretazione funzionale della cd. *Porticus Aemilia*, nei tentativi di comprensione e ricostruzione degli *horrea Galbana*, (fig. 1a), forse il più grande complesso di questa natura presente a Roma, costruito tra il versante sud-ovest dell'Aventino ed il Tevere, ma di cui, dal punto di vista archeologico, si sa in realtà poco<sup>8</sup>. Solo recentemente, a partire dal 2005, la Soprintendenza Speciale per i Beni Archeologici di Roma, oggi Soprintendenza Speciale per il Colosseo e l'Area Archeologica Centrale di Roma (SSCol), ha intrapreso, oltre alle citate ricerche sul porto fluviale, due grandi scavi, nel sito del Nuovo Mercato di Testaccio, ai piedi del Monte dei Cocci e nella stessa *Porticus Aemilia*, con tre campagne di ricerca realizzate insieme al KNIR-Reale Istituto Neerlandese a Roma nel 2011-2013<sup>9</sup>.

L'area di Testaccio, piccola ma con un tessuto storico ricco di tracce materiali di differenti epoche, ha una documentazione archeologica ampia e molto varia per natura, precisione e periodo in cui è stata prodotta. Alle moderne campagne di ricerca sopra citate si affianca pertanto una grande quantità d'informazioni proveniente da studi più limitati nell'estensione e nel tempo, da indagini geofisiche e geoarcheologiche, da scavi di emergenza, oltre alla massa ingente di dati raccolti tra la seconda metà dell'800 e la metà del '900, conservati in numerosi archivi statali, comunali e di molte società pubbliche e private che hanno nel tempo operato sul territorio.

La raccolta e l'organizzazione dei documenti di archivio ha un ruolo fondamentale per la ricerca scientifica e la ricostruzione della storia di questa parte della città, cuore logistico della Roma antica. Nel quadro del lavoro di sistematizzazione dei dati provenienti dagli archivi e dalle ricerche sul terreno recenti, intrapreso dalla SScol con la creazione di un sistema GIS appoggiato ad un DataBase topografico<sup>10</sup>, è stato firmato nel 2008 il protocollo d'intesa con il *Centro para el Estudio de la Interdependencia Provincial en la Antigüedad Clásica* - CEIPAC de la Universitat de Barcelona, di collaborazione nello studio dell'epigrafia anforica e di partecipazione al relativo programma di DataBase internazionale.

Lo studio dell'epigrafia anforica ha un ruolo importante nella ricostruzione della rete commerciale che coinvolgeva Roma e le provincie, e più in generale dei processi economico-sociali del mondo romano. Il sistema del CEIPAC ha permesso di fare un passo in avanti, mettendo concretamente a disposizione degli studi sull'economia romana un database funzionale, con una mole di dati impressionante per lo studio di questa particolare classe di informazioni. A Testaccio,

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<sup>8</sup> Sugli *horrea Galbana* vedi Coarelli 1996. Uno studio più recente e articolato degli *h. Galbana* è la tesi magistrale di Sara della Ricca (Università di Roma Sapienza, 2011 non pubblicata), mentre sugli *horrea* in generale, oltre al fondamentale lavoro di Rickman (1971) vedi, anche per la bibliografia, la recente Tesi di Dottorato di Milena Mimmo (Università di Padova, 2014, non pubblicato).

<sup>9</sup> Il *Porticus Aemilia Project* è un programma di ricerche condotto in collaborazione dalla SScol e dal Reale Istituto Neerlandese di Roma-KNIR, diretto da Gert-Jan Burgers della VU University di Amsterdam, già Direttore del KNIR, e da Renato Sebastiani della SScol. Il gruppo di ricerca è composto da, Alessia Contino e Raphaelle-Anne Kok-Merlino che curano la redazione della pubblicazione, da Evelyne Bukowiecki, Lucilla D'Alessandro, Sarah Della Giustina, Sara Della Ricca, Valerio De Leonardis, Matteo Merlino, Cornelia Tattoo, Franco Tella. I risultati sono in corso di studio. Per alcuni aspetti preliminari vedi la scheda pubblicata in FOL e nel website della Direzione Generale Antichità Belle Arti e Paesaggio del MiBACT e Burgers, Kok-Merlino, Sebastiani 2015.

<sup>10</sup> La ricerca e la schedatura sistematica dei dati d'archivio sono condotte da Sara Della Ricca e da Valerio De Leonardis ed è in corso di preparazione la pubblicazione del lavoro. Sostanziale è stato il supporto dell'équipe dell'Archivio Storico della SScol, in particolare di L. Attilia che ne ha la cura e di F. Filippi, che ne è stata lungimirante direttrice, a cui va il mio personale ringraziamento. Con loro ringrazio i direttori degli archivi comunali e statali che hanno concretamente contribuito alla ricerca.

anche attraverso questo strumento, la collaborazione tra gli studiosi spagnoli e italiani sta dando importanti frutti, non solo rispetto alle ricerche dirette sul Monte, ma per tutte le indagini in corso.

Il nuovo Proyecto EPNet (Economic and Political Networks), che si affianca al DataBase del CEIPAC, può a buon diritto essere considerata uno dei maggiori risultati e contributi che il gruppo di lavoro dell'Universitat de Barcelona coordinato da Josè Remesal Rodríguez sta offrendo alla ricerca sul sistema commerciale romano antico, a partire dall'osservatorio privilegiato del Testaccio.

Si illustrano di seguito sinteticamente i principali risultati delle ricerche archeologiche recenti svolte dalla SSCol a Testaccio. Si tratta di ricerche in corso per cui risultati sono ancora preliminari.

#### PORTO FLUVIALE ED EMPORIUM

Il nuovo porto fluviale<sup>11</sup>, sulla riva sinistra del Tevere ai piedi dell'Aventino, era formato in origine da un'area pavimentata e recintata, con moli di attracco per le imbarcazioni e una struttura retrostante definita *porticus*, la cui realizzazione viene fatta risalire dalle fonti<sup>12</sup> al 193 a.C. ad opera degli edili curuli *M. Emilius Lepidus* e *L. Emilius Paulus*. Lo stesso Tito Livio attribuisce a *Q. Fulvius Flaccus* e *A. Postumius Albinus* un secondo intervento, ca. vent'anni dopo (174 a.C.) in cui sarebbero state lastricate le banchine dell'*emporium* e restaurata (completata?) la *porticus* retrostante.

Delle opere di età repubblicana sono rimaste solo piccole parti della banchina in *opus quadratum* trovate a monte di Ponte Sublicio nel 1920 durante i lavori di sistemazione della riva. La banchina era dotata di bitte d'ormeggio di cui almeno alcune zoomorfe: se ne conserva una a testa di cinghiale, ricollocata nel muraglione moderno, e due a testa di leone ritrovate nell'area ma non più in posto<sup>13</sup>. La stessa banchina doveva reggere il terrapieno di sostegno della strada che usciva dalla Porta Trigemina delle Mura Serviane.

All'inizio dell'impero vennero costruiti alcuni ambienti in *opus reticulatum*, aperti con porte verso il fiume, poi suddivisi internamente in tre stanze successive in età adrianea. Tutta questa parte del complesso portuale venne demolita quasi totalmente nel primo ventennio del XX secolo con la costruzione dei muraglioni di difesa dalle piene del fiume.

A valle di ponte Sublicio, nel I secolo d.C. venne costruito un nuovo edificio, formato da due serie di stanze rettangolari orientate lungo l'asse del fiume, disposte su tre livelli con i soffitti a volta, illuminate da lucernari dal lato del Tevere e con porte carrabili sul lato opposto, verso la riva. Nel livello più alto rispetto al fiume sono ancora visibili poche tracce di un pavimento a mosaico.

Durante i principati di Traiano e Adriano, tra il 100 e il 125 d.C., probabilmente per difendere meglio il porto dalle piene del fiume, all'edificio originale ne venne aggiunto uno nuovo, con un lungo muro di fondazione e alcune stanze con la copertura a volta chiuso da un muro inclinato a scarpa. Venne realizzata una nuova banchina pavimentata con lastre di travertino e attrezzata con bitte di ormeggio fatte con pietre forate. Dalla banchina stessa si poteva accedere a nuove stanze voltate, costruite restaurando i locali di stoccaggio più antichi. (figg. 3-6)

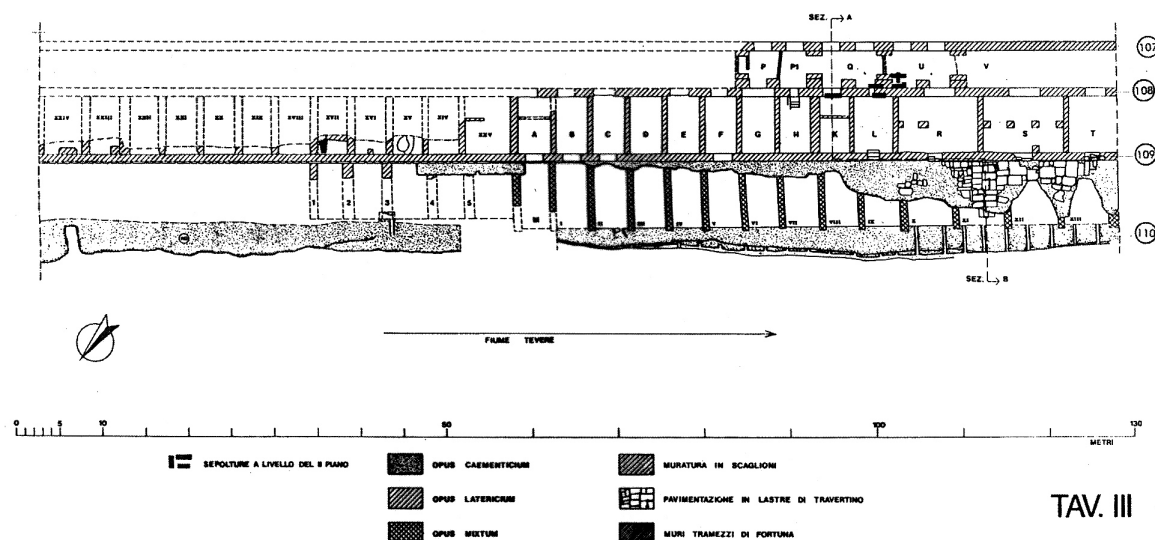
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<sup>11</sup> Gran parte delle informazioni sul porto fluviale riportate in questo articolo sono frutto della profonda conoscenza del sito e della cortesia di Edvige Patella, che ringrazio.

<sup>12</sup> Vedi sopra note 1, 2

<sup>13</sup> Una di queste è conservata nell'area demaniale dell'antico porto fluviale mentre l'altra si trova nel cortile dell'ex istituto S. Michele, sede della Direzione Generale Antichità, Belle Arti e Paesaggio del Ministro dei Beni e delle Attività Culturali e del Turismo.

Il criptoportico, illuminato dai lucernari, era lungo almeno 250 m. e si apriva, verso la città in una sequenza di stanze, in parte ancora conservate e parzialmente interrato sotto la strada moderna del lungotevere Testaccio (fig. 7).



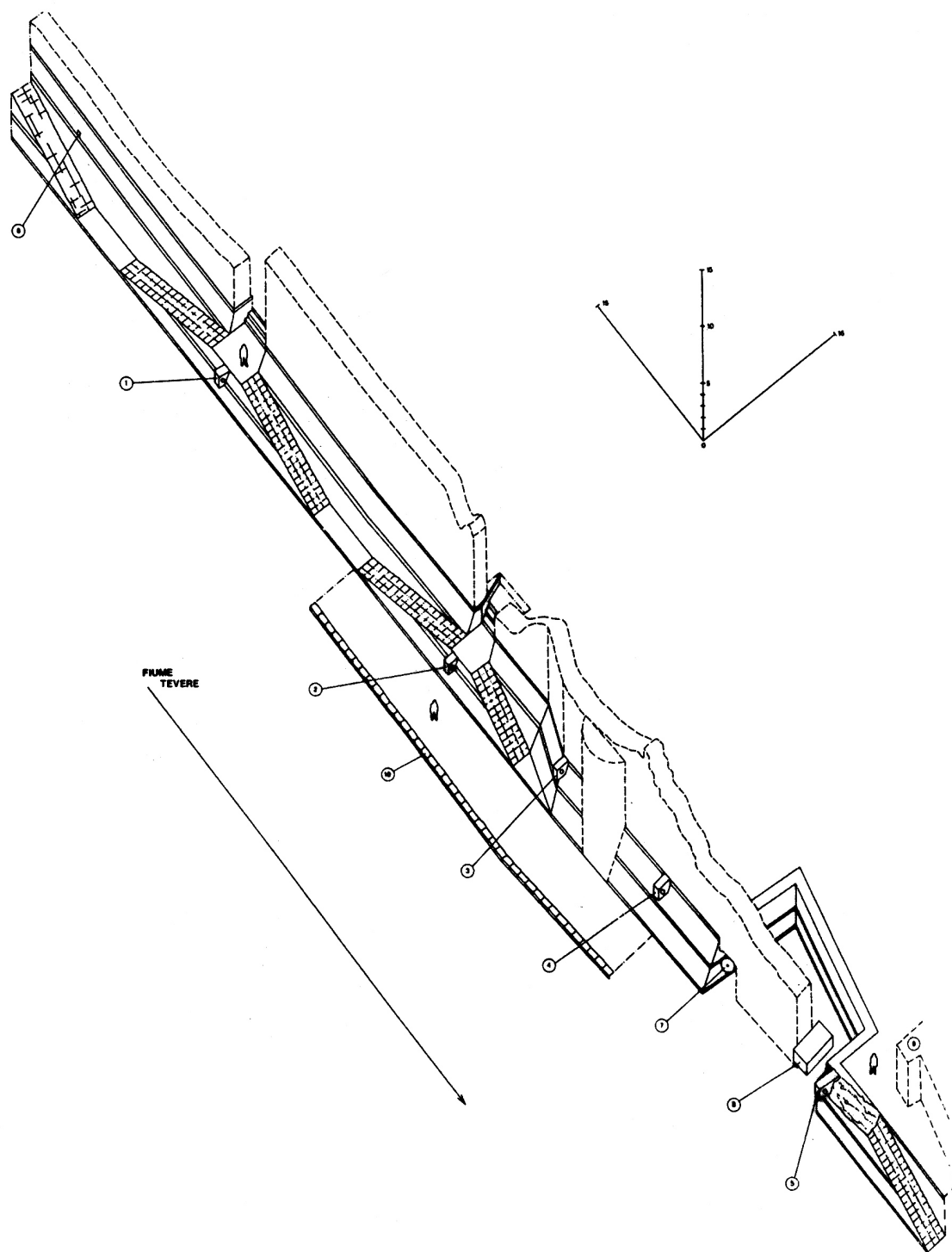
**Fig. 3. Emporium.** a) Pianta delle strutture di età traianea scavate negli anni ottanta del secolo scorso (Meneghini 1985).

I resti del porto e dell'*emporium* così sommariamente descritti, sono solo una parte del sistema portuale che doveva svilupparsi lungo il Tevere, sicuramente collegato anche al vecchio scalo a valle dell'isola Tiberina ed esteso probabilmente per più di un chilometro sulle due rive del fiume. Questo grande complesso portuale è stato per secoli, dalla tarda età repubblicana e per tutta l'età imperiale, la principale area di imbarco e sbarco e stoccaggio delle merci a Roma, direttamente legata al sistema portuale marittimo di Ostia-*Portus*, attraverso il Tevere e le vie Ostiense e Portuense.

Nel IV secolo d.C. molti ambienti della struttura portuale e il criptoportico furono abbandonati e colmati di terra e detriti. Tra i materiali ritrovati nel corso degli scavi, ci sono diversi frammenti di epigrafi legate alle corporazioni di artigiani e lavoratori presenti nell'area del porto fluviale.

Tra il V e il VII secolo d.C. le strutture portuali e di stoccaggio lungo la riva sinistra vennero progressivamente abbandonate, come testimonia la presenza di numerose sepolture risalenti a questo periodo, sia nelle strutture del porto stesso, sia nell'area retrostante della *Porticus Aemilia* e nel vicino sito del Nuovo Mercato di Testaccio. Il baricentro delle attività portuali interne si sposta nei secoli del medioevo e dell'età moderna sempre più sulle banchine della riva destra, nell'area dell'attuale rione di Trastevere, mentre l'antica zona logistica nella piana subaventina si ruralizza e assume progressivamente l'aspetto di campagna suburbana con orti, vigne e casali, che manterrà fino alla nascita del nuovo rione di Testaccio a partire dagli ultimi anni del XIX secolo.





**Fig. 4. Emporium. Assonometria ricostruttiva delle strutture intercettate da Bruzza durante le sue operazioni di scavo (Meneghini 1985).**



**Fig. 5. Emporium. Strutture traianee. visione di insieme. In primo piano le stanze superiori e la banchina di piena, visibili anche le sostruzioni inferiori poggianti sulla banchina di magra (foto SSBAR).**



**Fig. 6. Emporium. Strutture traianee. Banchina di piena (foto E. Patella).**





**Fig. 7. Emporium. Criptoportico di età traiana (Su gentile concessione dott.ssa Paola Di Manzano).**

#### *PORTICUS AEMILIA*

L'urbanizzazione della piana di Testaccio ai piedi dell'Aventino, legata alla realizzazione del nuovo porto fluviale, avvenne attraverso la costruzione di grandi edifici pubblici, il cui nome è legato a quello di importanti famiglie patrizie come la *gens Aemilia*. Come già sopra detto, secondo Tito Livio, nel 193 a.C. gli *aediles curules* Marco Emilio Lepido e Lucio Emilio Paolo, contemporaneamente alla prima fase di realizzazione del porto, iniziarono a costruire alle sue spalle un grande edificio a navate, tradizionalmente noto come *Porticus Aemilia*, terminato, sempre secondo Livio, vent'anni dopo, nel 174 a.C., dai censori Quinto Fulvio Flacco ed Aulo Postumio Albino. Localizzata tra le attuali via Marmorata, via Branca, via Franklin e via Vespucci, questa enorme struttura di 487 x 60 metri era divisa in 50 navate larghe 8,30 metri ciascuna, digradanti verso il Tevere. I suoi resti monumentali rappresentano ancora oggi un segno forte nel quartiere contemporaneo che ha caratterizzato nei secoli, insieme al Monte Testaccio e alle Mura Aureliane, il paesaggio della pianura subaventina (Fig. 8).

Le 50 navate della *Porticus Aemilia* erano coperte da volte a botte, il pavimento era in terra battuta e i muri costruiti in *opus incertum*, probabilmente databili ai lavori che Livio colloca nel 174 a.C. (fig. 9a, b)



**Fig. 8. Porticus Aemilia. Tratto del muro di fondo. Alle spalle la chiesa di Santa Maria Liberatrice. 1910. FU3240, 1910. Photographic Archive of American Academy in Rome.**

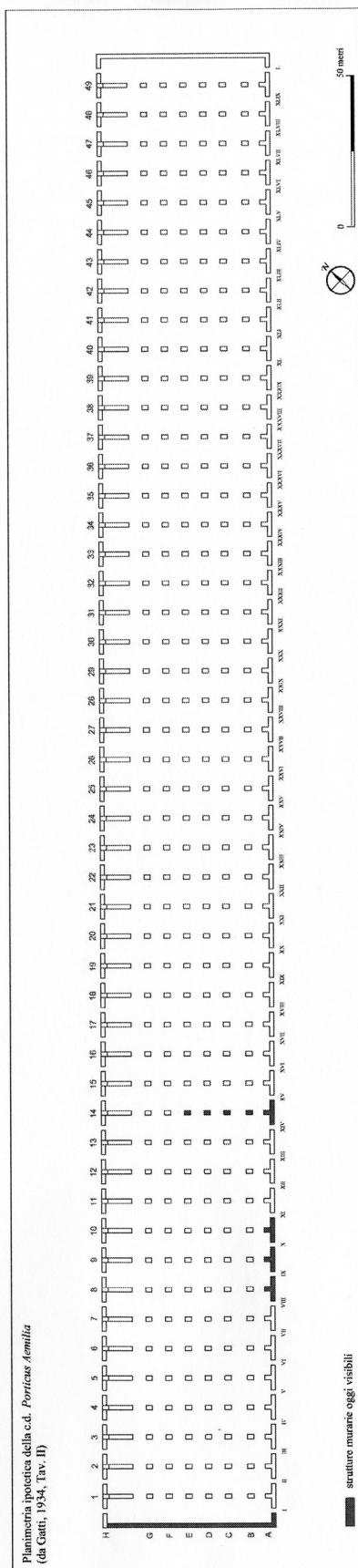
Nella metà del I secolo d.C., e in modo più ampio nel II secolo d.C. durante i principati di Traiano e Adriano, vennero fatti estesi restauri in *opus mixtum* con mattoni e blocchetti di tufo, con il probabile obiettivo funzionale di dividere le grandi navate dell'edificio originale in ambienti più piccoli.

I dati in nostro possesso provengono dalle fonti storiche antiche, dalla *Forma Urbis Severiana*, dalla *Forma Urbis* di Rodolfo Lanciani e dalle notizie di scavi realizzati tra la fine dell'800 e la prima metà del 900 per la costruzione del quartiere moderno, rielaborati nel 1934 da Guglielmo Gatti che diede l'attuale collocazione al frammento della *Forma urbis severiana* da lui stesso attribuito alla *Porticus Aemilia*.

Le conoscenze sull'edificio si sono accresciute grazie ai ritrovamenti di strutture antiche fatti nella seconda metà del '900 nelle strade tra il lungotevere Testaccio e piazza Santa Maria Liberatrice in occasione di interventi collegati alle infrastrutture cittadine e da ultimo dagli scavi condotti tra il 2011 e il 2013 dalla Soprintendenza Speciale per il Colosseo, il Museo Nazionale Romano e l'Area Archeologica di Roma-SSCol, e dal Reale Istituto Neerlandese a Roma-KNIR in tre navate (X, XV, XVI) e in uno spazio all'esterno del muro di fondo, di una porzione dell'edificio in un'area rimasta libera dai palazzi moderni.







**Fig. 9. b). Planimetria ricostruttiva. Nuova elaborazione grafica/ Plan after the excavation data (V. De Leonardis)**

I risultati di questi scavi, ancora in corso di studio, stanno fornendo molti nuovi dati preziosi per la comprensione dell'edificio, del suo contesto più generale e della sua storia nel tempo<sup>14</sup>.

Purtroppo scarsissime sono le informazioni sul fronte della *Porticus* verso il fiume ormai inaccessibile sotto i palazzi moderni del Lungotevere Testaccio.

I dati conosciuti ci permettono di delineare la struttura nel suo insieme ma lasciano aperti molti problemi interpretativi e funzionali.

Nell'ultimo decennio si è riaperta la discussione sulla funzione originale di questo grande edificio. La tradizionale interpretazione come magazzini del grano elaborata da Gatti nel 1934 è stata messa in discussione in particolare da Tucci che sulla base di dati epigrafici e topografici vi identifica invece nell'edificio i *Navalia*, gli arsenali militari della città.

Secondo chi scrive, sia l'interpretazione "classica" di Gatti, sia quella di Tucci, non sembrano al momento in grado di risolvere la questione della funzione originaria dell'edificio, ovvero la domanda: per quale uso fu costruito?<sup>15</sup>

Meno carico di suggestioni ma molto interessante è il quadro che sta emergendo dagli scavi SSCol-KNIR 2011-2013, che, pur in forma ancora molto preliminare, sembra indicare, almeno nelle tre navate scavate, diverse riorganizzazioni degli spazi funzionali avvenute nel corso della lunga vita dell'edificio. E' un dato che suggerisce un utilizzo molto articolato sia nello spazio (diversi usi contemporanei di parti dell'edificio) sia nel tempo (gli ultimi due secoli della repubblica e tutta l'età imperiale).

Nelle tre campagne di scavo è stata individuata la fondazione dell'edificio di età repubblicana, ma ad essa non erano collegati i relativi livelli di frequentazione né all'interno né all'esterno dell'edificio. Evidentemente essi sono stati rimossi ed eliminati dalle trasformazioni di età imperiale i cui livelli di calpestio si impostano infatti al di sotto della cresta della catena di fonazione repubblicana.

La fondazione in *opus incertum* è continua con i pilastri ammorsati alla fondazione stessa; l'opera si presenta come un intervento progettuale coerente, con evidenze di piani di lavoro e assestamenti in corso d'opera dovuti probabilmente alle difficoltà costruttive legate alle dimensioni dell'edificio e alle variazioni altimetriche del terreno prossimo alla riva del fiume.

Il lato lungo dell'edificio era rivolto verso il Tevere. I dati di scavo mostrano che la variazione di livello in direzione del fiume veniva riassorbita riducendo l'altezza della copertura ogni coppia di arcate dei muri divisorii delle navate e nell'abbassamento delle fondazioni di ca. 30 cm all'altezza di ogni arcata, ma l'assenza nei saggi effettuati di tracce del pavimento repubblicano non permette di sapere come questo dislivello fosse architettonicamente superato (fig. 10).

Ferme restando le già citate questioni, al momento irrisolte, della funzione originaria e della data di prima costruzione, l'edificio sembra tuttavia legato alle attività dell'*emporium*, almeno a partire dalla realizzazione e successivo completamento dello stesso, operazioni che Livio colloca nel 193 a.C.

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<sup>14</sup> Sono state condotte tre campagne di scavo tra il 2011 e il 2013 dall'allora Soprintendenza Speciale per i Beni Archeologici di Roma, oggi Soprintendenza Speciale per il Colosseo e l'Area archeologica centrale di Roma (SSCol) e dal KNIR nel quadro del *Porticus Aemilia Project*. Le indagini hanno interessato tre navate dell'edificio (X, XV e XVI) e lo spazio esterno all'edificio oltre il muro di fondo verso la città, all'altezza della navata X. I risultati delle ricerche sono in corso di pubblicazione (vedi nota 6).

<sup>15</sup> Non si affronta in questo scritto la complessa questione della funzione originaria della cd. *Porticus Aemilia*. L'ipotesi di Tucci, considerata plausibile da Coarelli (Coarelli 1996b), è in Tucci 2006 e Tucci 2012 con bibliografia precedente. Per una posizione diversa vedi Arata, Felici 2011. L'ipotesi classica in Gatti 1934.

e nel 174 a.C.<sup>16</sup>, servizi di controllo fiscale, vendita e distribuzione, movimentazione e stoccaggio temporaneo delle merci, ma forse anche manutenzione e riparazione delle imbarcazioni stesse.

Gli scavi 2011-2013 hanno messo in luce i vasti interventi fatti in diversi momenti dell'età imperiale. In corrispondenza delle navate XVI e XV le arcate su pilastri che suddividevano l'edificio repubblicano vennero chiuse e furono creati due spazi separati. I setti murari visibili presentano una fase che conserva la cortina e un ulteriore rialzamento, forse più tardo, che non conserva il paramento.

Nelle aree indagate, i piani di calpestio imperiali sono collocati ad una quota inferiore rispetto alle fondazioni di epoca repubblicana; questo elemento sembra indicare che gli interventi dell'età imperiale abbiano asportato i livelli precedenti, portando ad un abbassamento dei piani pavimentali dell'edificio, di cui non si comprendono al momento le ragioni.

Nella navata XVI sono stati individuati due vani: ad un livello inferiore un ambiente con muri in laterizio intonacati e pavimentazione integra, comunicante, tramite gradini, con un ambiente caratterizzato da un ingresso provvisto di due avancorpi in muratura e pavimento con *suspensurae*, che, sembra indicare come un magazzino per lo stoccaggio di derrate alimentari (fig. 11a,b). Il recupero di alcuni grani di farro, riconosciuti con analisi paleobotaniche<sup>17</sup>, tende a confermare l'ipotesi che si tratti di una cella orrearia per la conservazione dei cereali.

Sulla base dei materiali trovati nei livelli di fondazione e dell'analisi delle strutture murarie la *cella* presenta almeno due fasi costruttive: un primo intervento tra la fine del I sec. d.C. e l'inizio del II sec d.C., una seconda fase in età severiana.

Nel saggio interno alla X navata lungo il muro di fondo dell'edificio, al di sotto dei riempimenti tardo-antichi, sono stati individuati i resti di un pilastro in laterizio e forse del relativo piano di spiccato. Presumibilmente si tratta dei medesimi interventi di ristrutturazione che hanno interessato la *Porticus Aemilia* nella navata XVI, alla quale si allinea la datazione fornita dai materiali.

All'esterno della stessa X navata, a ridosso del muro di fondo, sono stati scavati due ambienti con muri in laterizio addossati all'edificio, databili per stratigrafia e materiali, all'età severiana. E' interessante notare che il frammento della *Forma urbis severiana* mostra uno spazio libero con un tracciato stradale all'esterno del muro di fondo della *Porticus Aemilia*, in contraddizione con questo ritrovamento. E' un dato che può avere diverse spiegazioni, sia cronologiche sia legate all'interpretazione della *forma urbis*.

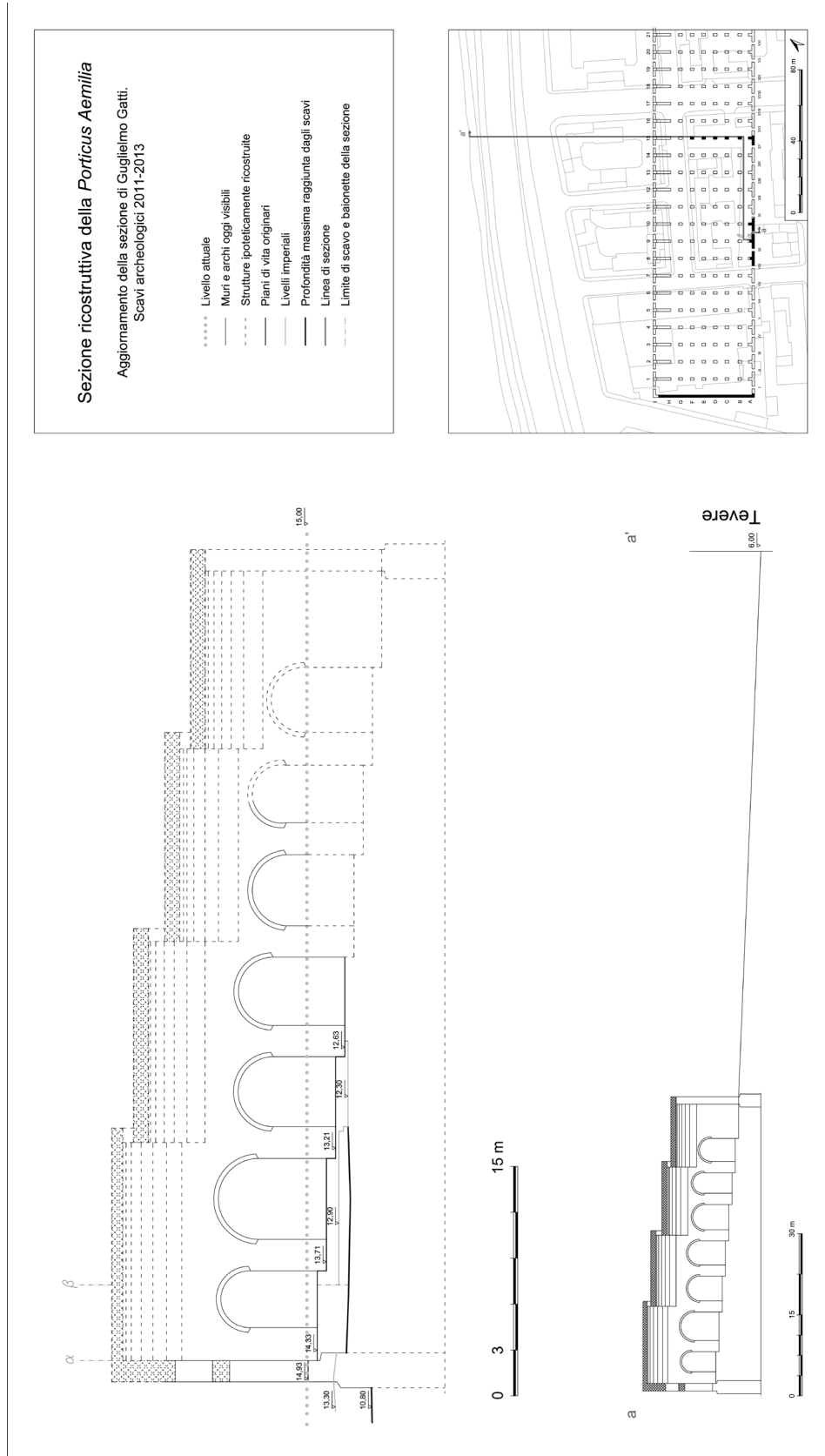
Nell'area esterna antistante gli ambienti sono stati individuati una fontana pubblica, con fogna sottostante, e i resti di una strada basolata (fig. 12).

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<sup>16</sup> Vedi nota 1

<sup>17</sup> Le analisi paleobotaniche sono di Daphne Lentjes.





**Fig. 10. Porticus Aemilia . Sezione ricostruttiva. Nuova elaborazione grafica (E. Bucowiecky, I. DE Ceglia, T. De Mauro).**

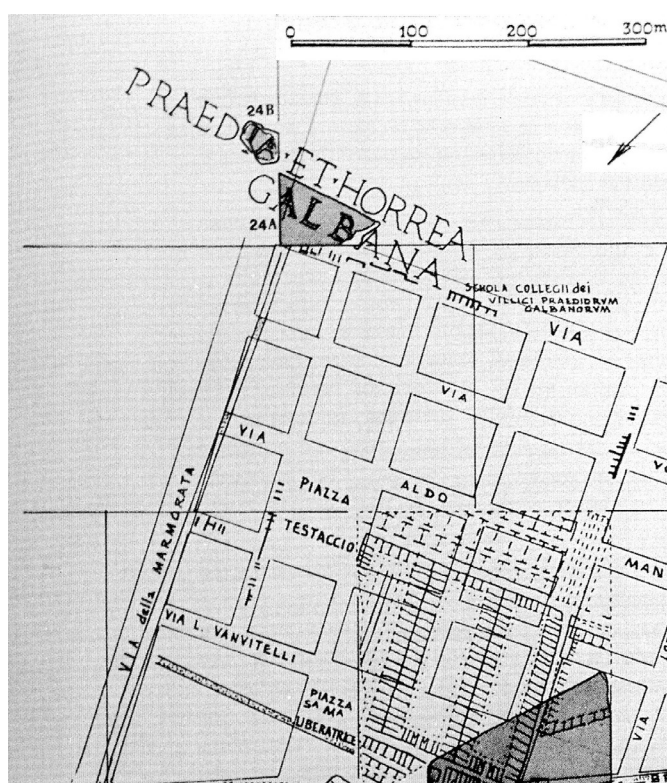


**Fig. 11. Porticus Aemilia. Navata XVI. A) Ambiente intonacato. Veduta aerea. B) ambiente con suspensurae (Foto SS-Col).**





**Fig. 12. Porticus Aemilia. Area Esterna. Ambienti, Fontana pubblica, fistula e fognatura (foto V. De Leonardis).**



**Fig.13. Horrea Galbana. Ricostruzione e ricomposizione della lastra 24 a-c della Forma Urbis Marmorea Serveriana (Almeida 1984).**

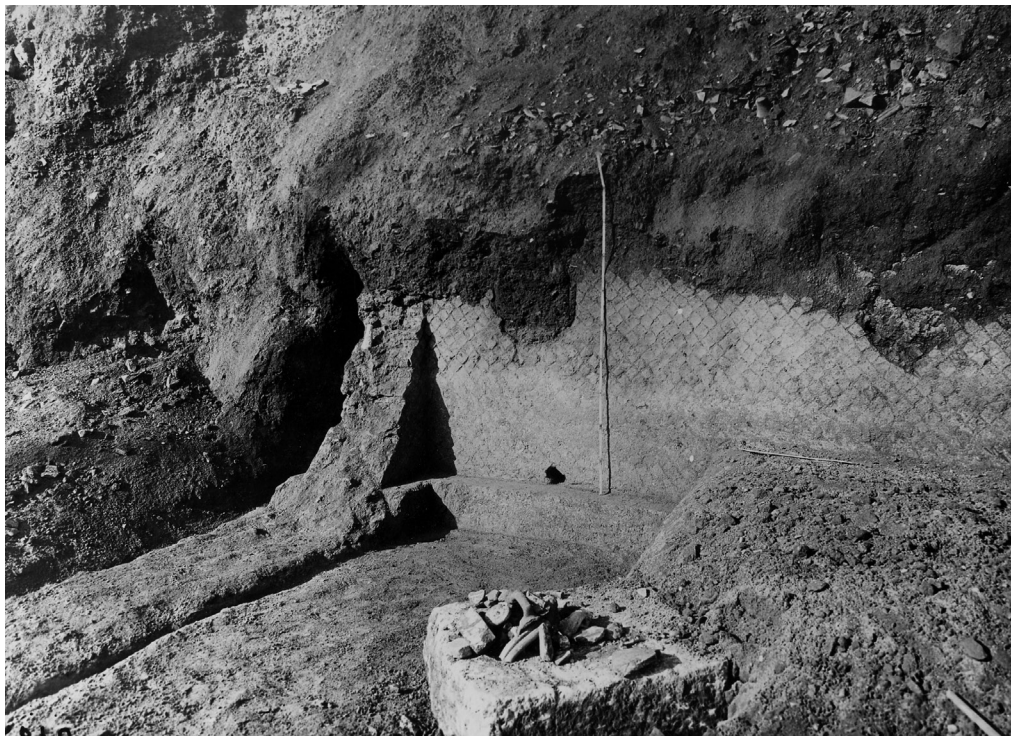


Gli *horrea Galbana*, (fig. 13) sono il vasto complesso di magazzini costruito tra il versante sud-ovest dell'Aventino ed il Tevere, di cui si hanno poche informazioni certe sulle caratteristiche architettoniche, strutturali e funzionali e di cui restano visibili, a parte qualche foto d'archivio, solo alcuni lacerti di murature sotto l'edificio che forma l'angolo tra piazza S. Maria Liberatrice e via Zabaglia (fig. 14).

Questa grande struttura, tanto nota quanto poco conosciuta, è un esempio della necessità di ricollocare i ritrovamenti noti e quelli provenienti da scavi di emergenza, la cui documentazione giace negli archivi, per comprendere meglio un contesto di estrema importanza per la ricostruzione della struttura economica della città antica e per definire linee di ricerca nuove.

L'indagine documentale, rivolta alla raccolta e al riordino sistematico del materiale d'archivio riferibile ai ritrovamenti ed alle sopravvivenze attribuibili al complesso, viene integrata con la ricognizione puntuale dei resti ancora presenti nelle cantine degli edifici moderni e con i dati relativi agli altri impianti, soprattutto orreari presenti nell'area.

La ricerca, condotta da Sara Della Ricca<sup>18</sup>, ha già permesso la messa a punto delle conoscenze sul complesso degli *horrea galbana* e sta fornendo elementi utili a una contestualizzazione storica degli interventi pianificatori che, nel II secolo a. C., favorirono la definizione di una specifica destinazione d'uso dell'intera piana subaventina e che, nel corso dei secoli, hanno confermato, almeno in parte, tale iniziale scelta urbanistica.



**Fig. 14. Horrea Galbana. Muri in opera quasi reticolata. FU5979, 1955. Photographic Archive of American Academy in Rome.**

<sup>18</sup> La ricerca sugli *horrea Galbana* è condotta da Sara Della Ricca e ha dato luogo ad una tesi di laurea magistrale (Della Ricca 2011) i cui risultati sono in corso di pubblicazione.



**Fig. 15. Campo Testaccio. Area di scavo. (foto GEA Scarl). Nel riquadro l'area dei Prati del popolo romano in cui ricade lo scavo.**

#### *CAMPO CALCIO TESTACCIO*<sup>19</sup>

Le campagne di indagine di archeologia preventiva nello storico campo di calcio dell'A.S. Roma a via Galvani a Testaccio, condotte nel 2010 sotto la direzione della SSCol dagli archeologi della soc. GEA srl<sup>20</sup>, stanno fornendo dati che, correttamente analizzati e contestualizzati, potrebbero apportare informazioni su alcuni elementi del paesaggio urbano di Testaccio, noti dalla cartografia storica, ma ad oggi non individuati in scavi archeologici, come i *praedia galbana* e i successivi "Prati del popolo romano" (fig. 15).

Gli scavi sembrano attestare l'esistenza di almeno tre fasi distinte. Alla frequentazione più antica, posta intorno a 10,00 m s.l.m., appartiene quello che sembra essere un canale scavato in un

<sup>19</sup> La ricerca sul campo Testaccio è condotta GEA S.C.a r.l. nelle persone del dott. A. Moro e del dott. D. Pantano e delle dott.sse F. Zabotti, I. Paolini, M. Ciccolini. I primi risultati sono in corso di pubblicazione.

<sup>20</sup> Alla campagna 2010 hanno partecipato anche Raphaëlle Anne Kok Merlino e Cornelia Tattoo per il KNIR-Reale Istituto Neerlandese a Roma



nucleo cementizio, questo ultimo forse pertinente ai resti di una fondazione in fossa di un alzataio di cui non è stata individuata però alcuna traccia. Il nucleo cementizio, risulta obliterato da una stratigrafia che, se verranno confermati i dati scaturiti da una prima analisi del materiale ceramico, sembra riferibile al III secolo d. C.

Questi livelli sono coperti da un battuto di terra legato probabilmente a un piano di frequentazione, a partire dal Medioevo, dei Prati del Popolo Romano. Il battuto è in parte coperto da uno strato di materiale ceramico di epoca romana, costituito quasi esclusivamente da anfore di produzione betica, in particolare Dressel 20, alcune delle quali bollate o recanti porzioni di *tituli picti*. Questo strato di frammenti di Dressel 20, le anfore più presenti quantitativamente sul Monte Testaccio, fa in prima istanza ipotizzare che, in un'epoca imprecisata dell'età moderna, il materiale sia stato "cavato" dalla base del monte per utilizzarlo ai fini di livellamento e drenaggio dell'area. Accumuli di frammenti anforici sembrano inoltre colmare fosse o dislivelli. L'uso dell'abbondantissimo materiale ceramico antico presente in tutta l'area di Testaccio (non solo il Monte dei Cocci) è d'altronde variamente attestato sia a livello archeologico, per esempio i battuti che costituivano il piano stradale del vicolo della Serpe ritrovati nello scavo del Nuovo Mercato di Testaccio, che letterario e normativo, si vedano a proposito i diversi editti di salvaguardia del Monte emessi dalle autorità pontificie, a partire da quello emanato da Benedetto XIV che nel 1742 proibisce "qualunque scavo, benché minimo de suddetti Cocci, e Terra..."<sup>21</sup> Lo studio analitico del materiale ceramico raccolto, confrontato con quello proveniente dalle ricerche sul Monte, permetterà di avere un quadro più chiaro su questo punto.



**Fig. 16. Nuovo Mercato Testaccio. Veduta dell'area di scavo (foto Akhet).**

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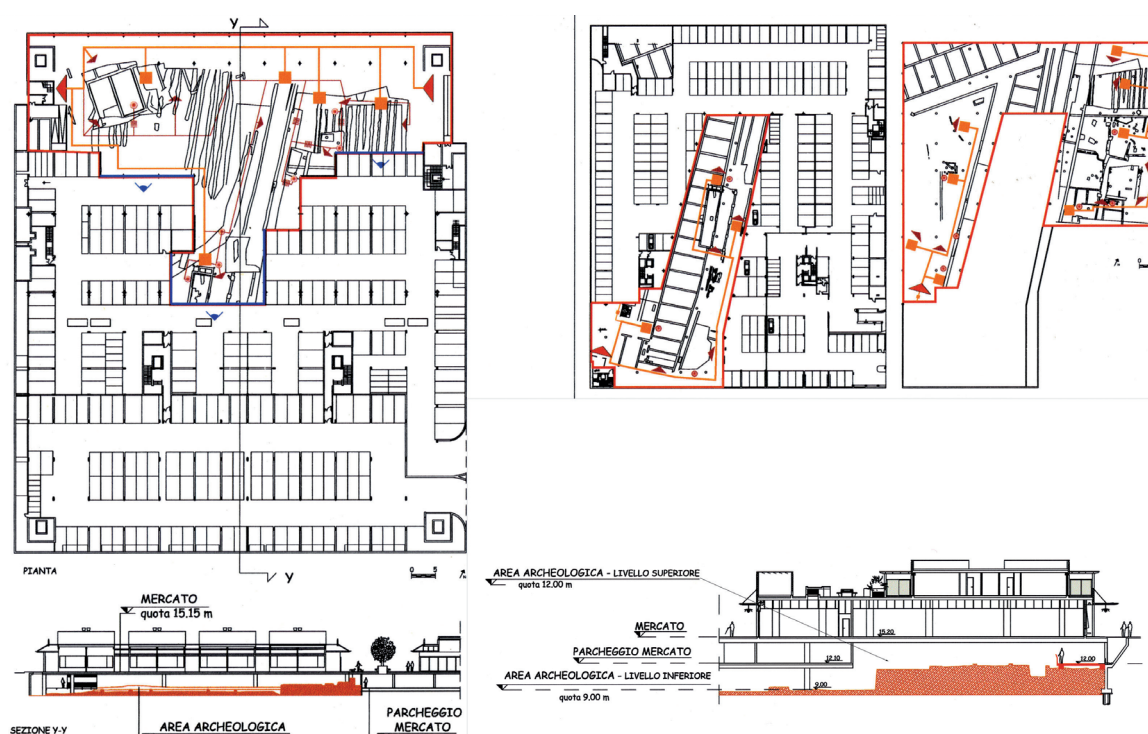
<sup>21</sup> Ramieri 2007, p. 390.

Infine, i diversi strati con battuti di terreno e lacerti di viabilità in terra battuta, datati ad età moderna, permettono di apprezzare “archeologicamente” la presenza e l’aspetto dei cosiddetti “Prati del popolo romano” mentre l’assenza, finora riscontrata, di resti chiari di edifici di età romana suggerisce una continuità nella tipologia di occupazione dell’area tra *Praedia Galbana* e “Prati del popolo romano”.

#### NUOVO MERCATO DI TESTACCIO

Il quadro delle conoscenze della storia della piana subaventina è stato arricchito nell’ultimo decennio dalla recente scoperta e dallo scavo di un vasto sito archeologico durante Nuovo Mercato di Testaccio (fig 16) in un’area che nella topografia antica è compresa tra la *Porticus Aemilia*, gli *horrea Galbana* e il Monte Testaccio.

Nel corso dello stesso anno 2005, la municipalità urbana ha avviato il progetto di un nuovo mercato coperto del rione Testaccio, attraverso la procedura del Project Financing, nella zona compresa tra le vie Franklin, Galvani, Ghiberti e Manuzio. La allora Soprintendenza Speciale per i Beni Archeologici di Roma, pertanto, ha intrapreso le indagini archeologiche preventive, funzionali alla realizzazione dell’opera: sondaggi a carotaggio continuo, prospezioni geoelettriche e alcuni saggi di scavo hanno consentito di delineare la stratigrafia generale del sito.



**Fig. 17. Progetto Nuovo Mercato Testaccio. Rapporto tra parcheggi e sito archeologico - Planimetrie e sezioni. A sinistra, una delle prime soluzioni che mostra il sito archeologico disposto su un unico livello e con superficie pari a circa la metà dei parcheggi; a destra l’ultima configurazione con il sito archeologico su due livelli e superfici equivalenti (composizione F. Riccio).**



In considerazione della rilevanza e del valore delle evidenze archeologiche, fin dal 2005, è stato promosso dalla Soprintendenza un articolato intervento di archeologia urbana che ha previsto lo scavo estensivo, conclusosi a novembre 2009, e la musealizzazione dell'area. Il progetto definitivo, diversamente dalla prima elaborazione, nel quadro di un'integrazione profonda tra spazio museale e struttura funzionale, contempla, all'interno del costruendo Nuovo Mercato di Testaccio, un'area archeologica ed una sala espositiva ludico-didattica, aperte al pubblico. Tale operazione è stata resa possibile anche grazie all'applicazione di professionalità e tecnologie adeguate che hanno permesso la realizzazione dell'intervento scientifico senza obliterare ma anzi integrando il progetto del Nuovo Mercato Testaccio<sup>22</sup> (fig. 17).

Questo scavo<sup>23</sup> condotto dalla SSCol ed esteso su un ettaro, offre una sequenza completa della presenza umana e dell'evoluzione del paesaggio in questa parte della città dalla prima età imperiale ad oggi.



**Fig. 18. Nuovo Mercato Testaccio. Pianta dell'area di scavo (elaborazione grafica G. Verde).**

<sup>22</sup> Ancona *et al.* 2012; Ancona, Contino 2007; Contino, D'Alessandro 2006.

<sup>23</sup> Lo scavo, iniziato con indagini geoarcheologiche e geofisiche, si è protratto in modo sistematico e continuo dal 2005 al 2009. Il progetto di ricerca del Nuovo Mercato di Testaccio non è ancora oggetto di una pubblicazione organica, essendo il contesto ancora in studio. I principali riferimenti bibliografici sono Sebastiani, Serlorenzi eds, 2007, 2008, Sebastiani, Serlorenzi 2011, Gallone Zottis 2011. Sul sito ANR-Entrepots è scaricabile in pdf

Lo scavo ha messo in luce una sequenza stratigrafica continua di ca. 7 metri (tra 15 e 8 m sul livello del mare), tipica di un contesto urbano a continuità di vita, che ripercorre un arco cronologico compreso tra le fasi dell'urbanizzazione contemporanea, il paesaggio suburbano di casali e orti di età moderna e medievale, e le fasi di epoca romana, i cui piani di vita sembrano collocarsi tra i 12 m sul livello del mare dell'età medio-tardo imperiale e gli 8-10 m sul livello del mare delle fasi primo imperiali (fig. 18).

La fase più antica individuata con chiarezza, compresa tra l'età tiberiana e l'età traianea, ha messo in luce nel settore nordorientale dello scavo, un sistema di ambienti coperti e cortili scoperti serviti da viabilità di servizio che risultano peculiari per il materiale da costruzione utilizzato. Tutti i "muri" del sistema sono infatti realizzati con anfore svuotate e reimpiegate impilate le une accanto alle altre (fig. 19).

Il sistema ha avuto almeno due fasi di vita. La prima, compresa tra l'età tiberiana e l'età neroniana, era costituita dai soli recinti realizzati allineando una accanto all'altra le anfore, vuotate del loro contenuto, infisse nel terreno. Gli spazi vuoti che si creavano in corrispondenza delle spalle e della parte inferiore del corpo dei recipienti, venivano colmati con frammenti di contenitori, legati da argilla compattata. Tale operazione permetteva di creare dei veri e propri muri perfettamente solidali (fig. 20).

Una seconda fase datata tra l'età neroniana e l'età flavia presenta una sistemazione dell'area attraverso la creazione di un muro in opera reticolata a nord che riduce lo spazio a disposizione, la riorganizzazione e sopraelevazione di alcuni recinti, la razionalizzazione degli spazi e della viabilità di servizio, l'edificazione di tre ambienti coperti nell'angolo sud-occidentale dello scavo.



**Fig. 19. Nuovo Mercato Testaccio. Settore orientale. Veduta d'insieme (foto D. Putortì).**





**Fig. 20. Nuovo Mercato Testaccio. Settore orientale. Allineamenti di anfore (foto D. Putortì).**

Le pareti di questi ambienti erano fatte con anfore impilate l'una sull'altra in modo da raggiungere la giusta altezza per il soffitto, legate con argilla pura (almeno tre per un'altezza di ca 2,50/2,70 m). Gli angoli erano costruiti in muratura, per assicurare una maggiore resistenza, necessaria per sostenere la copertura. L'interno era stato intonacato e in uno dei due ambienti ne sono state trovate tracce di colore azzurro e bianco. La copertura era fatta probabilmente con tegole, anch'esse ritrovate sparse sul terreno (fig. 21).

L'intero sistema era servito da passaggi dei quali è ben riconoscibile una piccola strada orientata N-S, formata da un battuto di argilla e frammenti di anfora compattati e un allineamento di 11 anfore sdraiate, poste al di sotto del piano di argilla. E' questo il solo caso in cui si può parlare con ragionevole certezza di uso delle anfore con funzione drenante (fig. 22).

L'area è stata interpretata come un ampio deposito/discarda a cielo aperto per materiali da reimpiegare nell'edilizia, i recinti erano infatti riempiti da diversi strati di materiale eterogeneo di spessore differente. In almeno due cortili le colmate sembrano differenziate per tipologia di materiale: anfore e *cubilia*, intenzionalmente distribuiti all'interno dello spazio. Gli ambienti erano probabilmente destinati al punto di registrazione delle entrate ed uscite del materiale conservato nei recinti e ad alloggio per i lavoratori.

Le ristrutturazioni che è stato possibile individuare sono probabilmente connesse ai continui interventi di sistemazione funzionale di un'area che, per almeno un secolo, sembra essere stata sfruttata per lo scarico e lo smaltimento di materiale ceramico ed edilizio.





**Fig. 21. Nuovo Mercato Testaccio. Settore orientale. Stanze realizzate nella seconda fase (foto S. Festuccia).**

L'uso delle anfore come materiale edilizio per la costruzione dell'intera struttura è certamente legato all'abbondanza e al facile reperimento di questo materiale nell'area portuale nonché alla necessità del loro smaltimento. Un reimpiego così ampio e sistematico costituisce effettivamente un caso estremamente peculiare, tuttavia è ben noto l'uso di anfore, non solo in diverse attività connesse all'edilizia (tubature, sistemi di alleggerimento delle volte, opere di drenaggio) ma anche a creare delle strutture murarie in particolari in siti manifatturieri connessi alla produzione di contenitori da trasporto: ad esempio un sito di fornaci in Spagna a Baetulo<sup>24</sup>.

Nella realizzazione dei muri di anfore sopra descritti, trovano largo impiego anfore di produzione adriatica, più di 500 esemplari sono ancora *in situ*, in grandissima maggioranza del tipo Dressel 6A (meno Dressel 2-4; 2 Dressel 6B), anfore vinarie derivate dalle Lamboglia 2 e fabbricate tra la metà/fine del I sec. a.C. e la metà del I sec. d.C.<sup>25</sup>

E' interessante notare che tra i bolli presenti su queste anfore, quello più rappresentato è *T.H.B.*, probabile abbreviazione dei *tria nomina* di un *T. Helvius Basila*, nel quale viene comunemente

<sup>24</sup> Contino, D'Alessandro 2015.

<sup>25</sup> D'Alessandro 2013. Pur nella complessità che accompagna le analisi archeometriche sul contenuto delle anfore, è interessante notare che la prima serie di analisi degli elementi in traccia effettuata da Florinda Notarstefano (DISTEBA-Univ. Salento) conferma la presenza di vino in questi contenitori.



ricosciuto il padre del proconsole e legato imperiale di Tiberio e di Claudio<sup>26</sup>, che si ipotizza fosse proprietario di *figlinae* in area picena, forse a Cupra Marittima (Ascoli Piceno).

Nel settore occidentale dello scavo sono stati individuati alcuni recinti realizzati con anfore, dotati di pavimentazione in terra battuta e forse copertura leggera, probabilmente coevi a quello del settore orientale ma destinati piuttosto al ricovero e allo stoccaggio forse temporaneo di materiali (fig 23).



**Fig. 22. Nuovo Mercato Testaccio. Settore orientale. Viabilità di servizio (foto D. Putorti).**

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<sup>26</sup> La datazione del bollo viene circoscritta ad età augustea o, al più tardi, al principio di quella tiberiana: D'Alessandro 2013 con bibliografia precedente.



L'abbandono del complesso dei recinti di anfore nel settore orientale è indicato da un livello alluvionale non rimosso che copre l'area sigillandola, prima della metà del II sec. d. C. La presenza di un livello alluvionale non rimosso indica infatti che la discarica era caduta in disuso poiché, nonostante le frequenti e periodiche esondazioni del Tevere, la costante manutenzione delle aree urbanizzate, con la rimozione degli accumuli lasciati dalle piene, garantiva la funzionalità degli spazi. A testimonianza di ciò nell'intera sequenza antropica riferibile all'età romana in quest'area, ricostruita con i sondaggi geoarcheologici e con lo scavo, non si riconoscono grandi livelli alluvionali, a differenza di aree prossime al fiume situate poco più a valle (es. l'area lungo la via Ostiense all'esterno delle Mura Aureliane).

Questo stesso strato alluvionale fa da piano d'imposta per le successive costruzioni di età medio-imperiale.

Sempre nella porzione orientale dell'area di scavo, a nord dei recinti di anfore e separata da questi da un muro continuo in opera reticolata, è stata individuata una fila di pilastri in travertino e peperino, disposti a distanze regolari, che delineano una struttura chiusa, coperta da un tetto in tegole e coppi, distrutta in antico da un incendio le cui tracce sono chiaramente visibili sulla struttura stessa. Al suo interno sono state rinvenute 149 anfore del tipo Dressel 20, disposte in file parallele in posizione obliqua appoggiate sulla pancia (fig 24). Sembra trattarsi della sola concentrazione di Dressel 20, notoriamente olearie, presente sullo scavo. Potrebbe trattarsi di un magazzino dove arrivavano anfore olearie vuote in attesa di essere smaltite. La posizione obliqua delle anfore e la stessa ridotta estensione delle tracce di incendio suggeriscono infatti l'idea che fossero già vuote.



**Fig. 23. Nuovo Mercato Testaccio. Settore occidentale. Recinti di anfore (foto S. Festuccia).**



**Fig. 25. Nuovo Mercato Testaccio. Settore ovest. Horreum. Veduta aerea (foto Akhet).**

La successiva fase di età medioimperiale è caratterizzata nella porzione occidentale dello scavo dai livelli di costruzione di un edificio di forma trapezoidale, identificato come *horreum*, costituito da file di ambienti rettangolari prospettanti su un ampio piazzale porticato centrale ed in parte obliterato dalle moderne via B. Franklin, a ovest, e via A. Manuzio, a nord. Della struttura orrearia si conservano esclusivamente i livelli di costruzione. L'*horreum* venne infatti interamente spoliato in età antica (inizi IV sec. d.C.) fino alle soglie del piano terreno (**fig. 25**). Le fondazioni dell'edificio vennero realizzate in parte in cassaforma in parte a "facciavista" in opera reticolata (**fig. 26**), come documentato anche nei siti di stoccaggio ostiensi, allo stesso modo venne realizzata la catena di fondazione del portico prospettante il cortile con la messa in opera sulla fondazione di plinti in peperino. Le fondazioni degli ambienti e del portico vennero poi riempiti con possenti colmate di terreno fino a raggiungere il livello di calpestio. Lo scopo era probabilmente quello di innalzare il livello dell'*horreum* forse per proteggerlo dalle piene del fiume che regolarmente inondavano la pianura. E' stato possibile determinare la sequenza costruttiva dei muri in reticolato che iniziò da quelli perimetrali esterni, seguiti dai setti divisorii interni, per terminare con il fronte delle *tabernae*.

I muri perimetrali, di maggior impegno statico, sono caratterizzati da uno spessore più rilevante (60 cm, contro i 45 cm delle restanti murature). La scarsa conservazione degli alzati e la sistematica opera di spoliazione, cui sono state sottoposte le strutture, non permettono una chiara ricostruzione dell'aspetto dell'edificio: si può tuttavia notare come tutti gli ambienti sembrano presentare un'unica apertura verso la corte centrale, larga costantemente 1,90 m circa. Inoltre, il ridotto spessore dei muri e l'ampiezza degli ambienti (larghi m. 4,50) fanno pensare ad un sistema di coperture con solai



lignei. La presenza di un secondo piano, o più probabilmente di una terrazza praticabile, appare suggerita dalla possibile identificazione di uno degli ambienti (il XVIII, caratterizzato da pareti laterali di maggior spessore) con un vano scala. Non è stata rinvenuta, infine, alcuna traccia di rivestimenti parietali o di decorazioni architettoniche.

Per quanto attiene la sua funzione la mancanza di *sospensurae* (intercapedini nei pavimenti per la circolazione dell'aria) sembra escludere l'utilizzo come deposito delle granaglie. Le analisi bioarcheologiche hanno però individuato tracce di grano nell'area dell'ambiente I. Non sembrano infine presenti sistemi di adduzione dell'acqua all'interno dell'edificio, il che parrebbe escludere attività artigianali più complesse e la possibilità di adibire l'area ad *ergastula*.



**Fig. 26. Nuovo Mercato Testaccio. Settore ovest. Horreum. Stato di conservazione degli ambienti e fondazioni dell'ambiente I (foto S. Festuccia).**

Nella parte orientale dello scavo, al di sopra del livello alluvionale che copre l'area di discarica, si sono individuati solo i labili resti delle fondazioni di quello che è stato identificato come un edificio a pilastri, probabilmente coevo all'*horreum* e anch'esso completamente spoliato in età antica.

Tra i due edifici è presente un corridoio la cui funzione è incerta. La porzione meridionale del muro del corridoio che si conserva in crollo *in situ* restituisce un'immagine degli originali alzati del complesso medio-imperiale e permette di illustrare le fasi di abbandono dell'area tra l'inizio del IV e il V sec. d.C. (fig. 27). Tale corridoio o *anditus* costituisce una divisione topografica e probabilmente proprietaria di lunga durata fra le aree, poiché la struttura attualmente presente, coeva agli edifici di stoccaggio, si imposta su un precedente muro di età flavia che a sua volta è fondato su un muro in opera quadrata, che costituisce la più antica testimonianza rinvenuta nello scavo.





**Fig. 27. Nuovo Mercato Testaccio. Settore occidentale. Horreum. Crollo del muro del corridoio in situ (foto S. Festuccia).**



**Fig. 28. Nuovo Mercato Testaccio. Settore orientale. Tracce di lavorazioni agricole (foto S.A.F. srl ).**



Per quanto riguarda l'epoca medievale, le labili tracce conservate hanno fatto ipotizzare una frequentazione sporadica, piuttosto che una vera e propria occupazione dell'area indagata. A partire dall'età rinascimentale, invece, le evidenze archeologiche testimoniano inequivocabilmente la vocazione agricola del territorio e il carattere rurale del paesaggio, che si conservarono fino a quando il Testaccio, alla fine dell'Ottocento, divenne un quartiere, seppure periferico, di Roma capitale. Alla fase rinascimentale appartengono tracce di attività agricola, costituite da solchi paralleli, il vicolo della Serpe, noto dalla cartografia storica, che corre *grosso modo* in direzione nord-sud e i resti di un casale rinascimentale (figg. 28-29). Della fase contemporanea lo scavo ha restituito le fondazioni di alcuni edifici di edilizia popolare noti come "villinetti", costruiti negli anni venti e demoliti alla fine degli anni 60, e i livelli di occupazione del campo sportivo dell'A.S. Roma<sup>27</sup>.



**Fig. 29. Nuovo Mercato Testaccio. Settore occidentale. Veduta aerea dei resti del Casale di età rinascimentale e del Vicolo della Serpe (foto Akhet).**

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<sup>27</sup> Sulla storia contemporanea del rione Ancona, Contino, D'Alessandro 2014 e Duranti, Puccini 2009 con bibliografia precedente.

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## LA CONTRIBUCIÓN DEL CEIPAC A LA HISTORIA ECONÓMICA DEL IMPERIO ROMANO

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*“It is a dangerous myth that we are better historians than our predecessors. We are not. But we come to the Roman history with different priorities – from gender identity to food supply – that makes the ancient past speak to us in a new idiom.”*

M. Beard

El párrafo que encabeza este trabajo recoge una elegante consideración sobre el desarrollo de la investigación sobre la Historia de Roma que procede del Prólogo de un reciente y excelente libro de divulgación sobre el Imperio Romano, escrito por una de las más reconocidas classicistas de Cambridge (Beard 2016: p. 16). Me parece interesante que la autora elija el **tópico del suministro de alimentos** como una de las líneas de aproximación más actuales e innovadores al pasado romano, junto al popular tema de la identidad de género. El simple hecho de que una reputada académica mencionar, como *exempla gratia* y en una obra destinada al llamado público generalista, un tema desde siempre central en el proyecto de investigación del CEIPAC, demuestra la relevancia y el carácter pionero del Centro para el Estudio de la Interdependencia Provincial en la Antigüedad Clásica (online en la *www* desde 7 de septiembre de 1995, más de veinte años de vida), un Proyecto abierto que combina la investigación histórica / arqueológica con la moderna herramienta de la *www*; simultáneamente, demuestra la oportunidad del presente Proyecto (EP.net) y respectiva reunión científica.

El propósito del CEIPAC no ha sido muy diferente del que en su día Mommsen propuso con el *Corpus Inscriptionum Latinarum* (CIL). Desde la percepción de que no se puede hacer la historia económica del Imperio Romano con las fuentes disponibles, el CEIPAC ha ensayado estrategias de

construcción crítica de las fuentes y construye un nuevo *Corpus*, que integra catálogos locales, regionales o de yacimientos, sobre una base crítica. Su objetivo es, justamente, la construcción de una historia económica de Roma en el futuro (Remesal Rodríguez, 2012). La elección de unas minucias epigráficas debidamente leídas y publicadas constituye una buena estrategia, una vez que los sellos sobre ánforas, una expresiva manifestación de la llamada epigrafía de la producción (Harris, 1993), pueden considerarse como los más objetivos indicadores de los intercambios entre distintas regiones del Imperio Romano. Las premisas de este análisis son el conocimiento del lugar de producción de la ánfora sellada y la consideración de que una ánfora es un recipiente de transporte y que su contenido (alimentos de diversos tipos) en muchos casos se conoce también, depreniendo que el lugar de producción del alimento es el mismo que del contenedor y que el lugar de descarte se corresponde al de lo consumo final.

A través del catálogo sistemático de los sellos sobre ánforas, el CEIPAC pretende contribuir positivamente al análisis y discusión de la Economía antigua y sus principales aspectos, valorando especialmente el problema de los intercambios entre las distintas regiones del Imperio Romano. Con ello, el CEIPAC pretende intervenir activa y positivamente en el estudio de la historia económica de la Antigüedad. Naturalmente, sus responsables entendieron desde siempre que el tema central para el futuro desarrollo de la investigación y conocimiento era la naturaleza y cualidad de las fuentes elegibles para el estudio del tema y, por eso, se privilegiarían los sellos y no solamente las ánforas.

En este proceso de elección de las minucias epigráficas, valoradas por H. Dressel en su día, pero menos consideradas posteriormente, surgió, de forma natural, el intento de trabajar de nuevo, con nuevos planteamientos el Monte Testaccio de Roma, el gran archivo del suministro de alimentos a la *Urbs*. En este lugar, junto a los sellos, hay la riquísima información de los *tituli picti* y grafitos, que no se encuentra fácilmente en otros contextos. Más de dos décadas de trabajo y de criteriosa publicación confirman lo acertado de esta decisión (Blázquez Martínez; Remesal Rodríguez; Rodríguez Almeida, 1994; Blázquez Martínez; Remesal Rodríguez, 1999; 2001; 2003; 2007; 2010).

El gigantesco sistema de suministro alimentario de Roma puede entenderse como una prueba del interés y la participación del Estado en la economía del Imperio Romano, sin negar, con ello, la participación de los privados. Basta citar, a título de ejemplo, el caso de los suministros institucionales a Roma, emblemáticamente asociados al Testaccio, un enorme vertedero de ánforas de aceite bético y africano desechadas. (Remesal Rodríguez, 1986; Blázquez Martínez; Remesal Rodríguez; Rodríguez Almeida, 1994; Blázquez Martínez; Remesal Rodríguez, 1999; 2001; 2003; 2007; 2010). En los contextos arqueológicos de Roma, las ánforas de tipo Dressel 20 asumen una dimensión significativa, como muestran los registros de los dos primeros siglos de la Era, estudiados por G. Rizzo. En los niveles arqueológicos neronianos las ánforas hispanas se registran en cantidad apreciable, con dominio de las olearias – Hispania es la segunda región más representada, detrás de la Península Itálica. En la etapa siguiente, de época Flavia, continúan dominando las ánforas de tipo Dressel 20, entre las importaciones hispanas y esta región sigue estando bien representada. En época de Trajano se produce un significativo crecimiento; un fenómeno con continuidad, aunque de forma menos expresiva, en época Antonina (Rizzo, 2003: p. 144-169).

Naturalmente, el transporte de las ánforas olearias béticas hasta la capital del Imperio se produce en el ámbito del suministro institucional, implicando o no privados en este proceso. Sin embargo, no es ilógico suponer que lo que llega a otros lugares y consumidores de la ciudad parece el resultado del funcionamiento de un circuito distinto, quizás interesando más el ámbito privado, de mercado, en la plena acepción del término, frente a lo que registra el Testaccio. Así podremos suponer que la mayor parte de esas ánforas llega porque el suministro institucional existe, pero no

cuesta admitir que aprovechando ese gran circuito otras acciones y actores, probablemente en ámbito privado actuaron en la capital del Imperio. Combinando el tema del estudio de la epigrafía sobre ánforas con el estudio de las mismas se pueden dibujar propuestas e hipótesis sobre la llegada a la *Urbs* del aceite de oliva bético.

Pero, volviendo al tema de la contribución del CEIPAC a la Historia Económica del Imperio Romano, quizás sería necesario comenzar por una pregunta muy sencilla, porque las preguntas sencillas conducen a temas de mayor complejidad. Así, si hablamos de historia económica, importa comenzar con la definición básica de lo que es la historia económica.

Una definición sencilla sería: la Historia Económica consiste en el estudio de los aspectos económicos del pasado, sobre todo el problema de la *localización, distribución y adquisición de bienes y servicios*, resultantes de la *escasez* (indicamos en *italicas* las palabras clave tema de nuestro juicio). En este sentido, se podrá decir que hay una historia económica desde que existen sociedades humanas. Pero, una otra definición posible y utilizada con frecuencia sería: la Historia Económica supone la aplicación de los conceptos y herramientas propias de la ciencia económica a temas y problemas del pasado. Naturalmente, estas dos definiciones no se excluyen mutuamente pero son posibles de generar equivocaciones. Es importante considerar la cuestión del origen, sobre todo porque los inicios de la moderna historia económica están dominados por temas y cuestiones que salen fuera del ámbito de la Antigüedad o que se pueden considerar inadecuados para entender las realidades económicas del mundo Antiguo. Por ejemplo, la historia económica suele ser una Historia cuantitativa / serial, estudio de precios y de ciclos económicos. Por eso, no sería posible hacer esa historia económica de la Antigüedad por absoluta falta de fuentes o sería particularmente difícil, una vez más por la naturaleza de las fuentes disponibles, como el clásico libro de Duncan-Jones demuestra (Duncan-Jones, 1982); también se podría considerar esa historia como un ensayo inútil, no solamente por la falta de fuentes sino porque el mundo antiguo no cuidaba particularmente de los temas cuantitativos, como defendió en su día Finley, en un clásico libro que enmarca la “ortodoxia primitivista” en la lectura de la economía antigua (Finley, 1999).

Naturalmente, se podrían plantear otras perspectivas, como la discusión sobre lo que era la teorización de los hechos económicos en el mundo antiguo, un tema igualmente caro a Finley. Este investigador, sin embargo, no valoró particularmente *Los Economicos*, la obra del *corpus aristotelicum*, interesante por varios conceptos; sobre todo por la relevancia atribuida al suministro de alimentos a la *polis* o a los ejércitos, en los distintos ejemplos listados en el libro segundo. Igualmente, se podría valorar la aplicación de los modelos generados por la moderna ciencia económica al mundo antiguo, que sigue teniendo seguidores. Puede mencionarse, a título de ejemplo, el reciente artículo de Ryan M. Geraghty, que aplicando modelos de equilibrio general (usualmente utilizados en los estudios sobre la “globalización”) a la realidad del Imperio Romano, supone que los romanos eran actores económicos racionales y que la economía romana constituía un sistema de mercado bien integrado (Geraghty, 2007). Menciono solamente este ejemplo para subrayar como sería extenso (interminable, incluso) el abanico de temas que una discusión sobre la historia económica de la Antigüedad permite, pero también porque el debate y polémica sobre estos temas pasa siempre por la discusión sobre la cualidad de las fuentes usadas.

Tampoco interesa abordar el conocido debate entre los llamados “modernistas” y “primitivistas” en la lectura de la Economía del Imperio Romano. El tema es por demás tratado y, en realidad, la sensación que tengo es la de que se trata en buena parte de un diálogo de sordos, donde unos y otros más que confrontar argumentos propios con los ajenos, confrontan sus ideas con la imagen construi-



da de las tesis de sus oponentes. Creo que algunas buenas síntesis del tema han sido recientemente planteadas, como la de I. Morris, en el prólogo a la edición actualizada del libro de Finley. En su texto, además de contextualizar la obra del Profesor de Cambridge, Morris presenta los principales argumentos que contestan la visión de Finley. Entre ellos, figura la idea de la débil dimensión del comercio antiguo y su limitada escala espacial, una cuestión básica para todo investigador que estudia el Mundo Clásico a partir del registro arqueológico (Morris, 1999: xxviii, xxix). Esa contestación nace y se basa fundamentalmente en el registro arqueológico que, dígame en descargo de Finley, creció exponencialmente en las últimas décadas, generando un creciente volumen de información fiable. Una vez más, este es también un territorio de elección del CEIPAC. Estas cuestiones han sido tratadas recientemente por M. Scapini, quien plantea también una extensa y bien fundamentada discusión crítica sobre los distintos modelos de la economía antigua y como el estudio del tema del suministro de alimentos se integra plenamente en el debate (Scapini, e.p.)<sup>1</sup>.

Con todo, hay que destacar que la contestación a la perspectiva minimalista de Finley surgió casi inmediatamente tras la publicación de la primera edición de su libro. Esto se aprecia en la obra colectiva publicada por sus discípulos (Garnsey; Hopkins; Whittaker, 1983). En este volumen, además de muchas otras contribuciones relevantes, querría destacar el artículo de A. Tchernia sobre la difusión del vino itálico en la Galia y Sur de la Gran Bretaña a finales de la República (Tchernia, 1983). El mapa de distribución es muy revelador, representa el estado de la cuestión en su día, demostrando, en primer lugar, la gran difusión, pero también el volumen implícito en la dispersión de los puntos que indican la presencia de ánforas del tipo Dressel 1 itálico (*Idem*: p. 89). Es interesante notar que los modernos mapas de distribución de las ánforas itálicas tardo republicanas en territorio galo no recurren ya a la representación sencilla de puntos, sino que utilizan diferentes dimensiones de círculos en función de las cantidades de ánforas registradas en cada sitio arqueológico, como en el mapa publicado recientemente por M. Poux (Poux, 2009: 97). La gran difusión geográfica de estas ánforas y la escala del fenómeno son hechos aceptados generalmente e importa ahora evaluar la relevancia relativa de cada lugar de consumo. Esto supone un efectivo reconocimiento de la relevancia de la cuantificación en los estudios económicos, que se puede hacer desde el registro arqueológico siempre que se disponga de información de calidad. Naturalmente, el progreso de la investigación y la creciente sofisticación de los estudios permiten hoy dibujar cartografías más ricas y complejas que en el pasado y de este modo acercar más el estudio del pasado romano a los tradicionales cuestionarios de la Historia Económica de otras épocas. En otras palabras, la cuantificación ha devenido un tema central en el registro arqueológico, superando la tendencia tradicional a la valoración cualitativa y aproximativa de los hallazgos individuales.

Por otro lado, la solidez de la información disponible para cada caso (o sitio) hace más complejo leer e interpretar los espacios en blanco en estas cartografías. Los vacíos pueden reflejar ausencias de importaciones o simplemente ausencia de información, una vez que en el registro arqueológico ausencia de evidencia no significa necesariamente evidencia de ausencia. Esto hace que nuestras representaciones más cartografías de la investigación que reales cartas de diseminación de ítems. Este sigue siendo, sin duda, un problema con que se confronta la investigación y que solamente el crecimiento exponencial de la información críticamente controlada permitirá resolver.

Junto a las zonas en blanco, existen los puntos que son sin duda una evidencia positiva (aunque se pueda discutir su significado no se podrá negar su existencia) como demostración de los

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<sup>1</sup> Agradezco a la autora el conocimiento de un *draft* pre-publicación de este texto.

intercambios entre distintas regiones. Este es uno de los argumentos más fuertes de los “modernistas”, basado en el registro arqueológico; tanto más fuerte cuanto que se puede tomar como argumento neutro de incuestionable validez: la verificación de una amplia distribución de ítems materiales, que viajan por todo el Imperio Romano, como en su día señaló Rostovtzeff (1963). Moses Finley negó la relevancia y magnitud de la dispersión de los materiales arqueológicos en el Mundo Antiguo. En su perspectiva, solamente se trataba de una distribución episódica, que podía explicarse en la función redistributiva del Estado. Esto generó la respuesta de André Tchernia, que elaboró el ya mencionado mapa de distribución de las ánforas vinarias itálicas de tipo Dressel 1 en Francia como demostración de la gran difusión y magnitud del fenómeno.

Volviendo al CEIPAC, se podrá preguntar el porqué de una estrategia centrada en la epigrafía de las ánforas como tema de trabajo. Las respuestas son múltiples: porque las ánforas son contenedores de alimentos; porque se puede determinar su origen (y así postular la origen del contenido); finalmente, porque puede determinarse el lugar de amortización / descarga del contenido (en la mayoría de los casos, el lugar donde se encontró la ánfora). El estudio de estos factores permite identificar una relación de interdependencia entre dos regiones del imperio Romano y hay que subrayar que esa interdependencia puede resultar de distintos contextos (distribución institucional, intercambio entre miembros de elite, libre comercio, etc.), por eso el tema estará siempre más allá de la discusión entre “primitivistas” o “modernistas” y, hay que decirlo, podrá servir de fuente y / o argumento para todos, independientemente de su perspectiva.

Este es un concepto importante subyacente al Proyecto CEIPAC, la idea de un proyecto abierto, colectivo e inclusivo de construcción de información: todos podrán participar en ello, todos beneficiarán de ello. Se carga solamente información previamente publicada, garantizando así la cooperación de todos en la calidad de la información; se abre a todo el mundo la posibilidad de incrementar la base de datos y de ensayar sus estudios de ámbito macro (como lo de los grandes suministros institucionales), como en el ámbito micro (los pequeños intercambios perceptibles en un cualquier sitio o región). El volumen de información de la base de datos CEIPAC nos advierte para el tema de la pluralidad de contextos de la interactividad en el interior del imperio Romano, de algún modo superando la discusión de “modernistas” y “primitivistas”, aunque su volumen apunte más en las direcciones normalmente invocados por los “modernistas” y no tanto al encuentro de las restricciones / limitaciones subrayadas por los “primitivistas”. El trabajo del CEIPAC contribuye a la superación del debate con la demostración de la multiplicidad de situaciones y de la complejidad de la economía del Imperio Romano y ese es uno de sus enormes méritos.

Para ilustrar este hecho voy a utilizar un par de ejemplos tomados desde la *Lusitania*, la más occidental de las provincias romanas, y por eso tomada o como *finis terrae*, periferia de la periferia o, como otros defienden, como un importante lugar de paso en la comunicación entre las regiones más septentrionales del Imperio y su centro Mediterráneo.

En la etapa de la conquista del occidente hispano se documenta la presencia regular de ánforas vinarias itálicas. Como en otro lugar comenté, no hay registro de una presencia de importaciones itálicas anteriores al proceso de conquista (Fabião, 1998: p. 175-176), contrariamente al caso galo, ya comentado a propósito de los mapas de Tchernia y Poux. La presencia de ánforas greco-itálicas es significativa de los primeros momentos de campañas militares, como recientemente se ha indicado (Fabião, 2014: p. 12-13). Las importaciones, tanto de origen tirrénica, como las oriundas del área brindisina, se documentan desde la segunda mitad del siglo II continuando en la primera mitad del I a.C. (Fabião et al, 2016: 115-117). Los mapas que publiqué en 1998 se han actualizado (Pimenta,

2005, p. 119-122). En estos mapas, además, se presenta de una forma sistemática la cuantificación de los hallazgos (*Idem*: pp. 114-118), dando una nueva dimensión a la análisis.

Podremos admitir que todo ese proceso ocurre todavía en ámbito de las operaciones de conquista y consolidación de la administración romana. Pero, en épocas más tardías, las importaciones de vino itálico prosiguen en distintas áreas lusitanas (Fabião, 1998: p. 178-181). Tomando en consideración solamente los sellos conocidos, se documenta la presencia de dos sellos sobre ánforas tirrénicas del tipo Dressel 2-4, uno, MAR OF, procedente de un contexto subacuático de la Península de Lisboa (Cardoso; Rodrigues, 2016); otro, ATEMO, encontrado en *Conimbriga* (agradezco a Ida Buraca la información). Ambos hallazgos se asocian al tipo 8 de las ánforas itálicas de ansas bífidas de Panella y Fano (Panella; Fano, 1977: p. 161-2, Fig. 48). Las ánforas itálicas del tipo Dressel 2-4 están también documentadas en la capital lusitana *Avgvsta Emerita*, tanto por sus sellos (Fabião *et al.*, 2016: p. 22-25), como por sus fragmentos identificados y cuantificados en la intervención arqueológica de los Cuarteles Hernán Cortés (Almeida; Sánchez Hidalgo, 2013). También en la ciudad de *Olisipo* se documenta la presencia de estas ánforas vinarias itálicas (Almeida; Filipe, 2013: p. 742). Se trata de un hallazgo interesante para evaluar como se dibujaban los circuitos de distribución que creemos esencialmente privados, por no existir razón para suponer un interés institucional en ese proceso, a menos que no se tratase de una iniciativa concreta de algún emperador por la capital provincial. Pero, en la apreciación / discusión del tema entramos ya en el dominio de la interpretación de lo que son los datos concretos: presencia de ánforas tirrénicas del tipo Dressel 2-4 en el litoral de la *Lusitania* y en la capital provincial, con una geografía francamente interior e imposible de suministrar de un modo directo desde Italia (véase Mapa de la Figura 1).

El descenso o incluso la desaparición de las importaciones de ánforas vinarias tirrénicas con las bien conocidas pastas con material volcánico pueden estar tan relacionado con la concurrencia de vinos de otras regiones y el declive del comercio de vino a larga distancia (como sugerí en otro lugar: Fabião, 1998: p. 183-185), como con el impacto de la erupción vesubiana en la producción vinaria de la región como ha sido sugerido por David Williams (Williams, 2004).

Un fenómeno análogo se aprecia con las ánforas vinarias galas. Su presencia en el occidente peninsular era ya conocida, siempre en pequeñas cantidades, pero muy frecuentemente presentes (Fabião, 1998: p. 183-185; Almeida; Filipe, 2013: p. 742). Atendiendo a los sellos conocidos, se documenta su presencia en *Olisipo* y en *Avgvsta Emerita*, o sea, en la capital provincial y en el que sería su principal puerto marítimo (Fabião *et al.*, 2016); en ambos casos en pequeñas cantidades (Almeida; Filipe, 2013; Almeida; Sánchez Hidalgo, 2013: p.52). Una vez más, no creo que haya ninguna razón para suponer que ese circuito tuviera algo de institucional, siendo por eso el resultado natural de la circulación de productos alimentarios en el ámbito del mercado. Es una geografía interesante y de algún modo esperable, dada la capacidad de atracción que tendría una capital provincial y la conexión con un lugar que sería, por todas las razones, uno de sus puertos marítimos, muy probablemente el principal. En un futuro, la cartografía de ocurrencias de estos sellos puede (o no) crecer, enriqueciendo y complejizando el panorama, sin todavía anular estas primeras deducciones, en primer lugar, la de una importación de vinos galos en *Lusitania* y, por otro lado, la existencia de una conexión entre la interior capital de la provincia y uno de sus puertos atlánticos, o sea, un proceso de recepción y redistribución en sentido Oeste-Este – véase Mapa de la Figura 2.

En épocas más avanzadas, cuando de un modo muy claro se estableció un circuito atlántico de suministro de aceite de oliva a la *Britannia* y a la *Germania Inferior* (Carreras Monfort; Funari; 1998) la *Lusitania*, por su localización, debió beneficiarse de ese circuito para recibir algo de ese

aceite. Sin embargo, analizando al panorama conocido de sellos sobre ánforas Dressel 20 registrados en los sitios arqueológicos portugueses, la imagen se muestra más compleja. Junto a los sellos de gran circulación, bien documentados en parajes septentrionales – MAR; QCR; LVA; ACIRGI; PNN -; aparecen otros poco conocidos y sobre todo absolutamente desconocidos en aquellas áreas: GDEC; MCVAR; SPERATVS; SVDEGR; QRFLCORNEL (Fabião *et al.*, 2016: p. 118-119) - véase los Mapas de las Figuras 3 y 4. Esto permite proponer que no es solamente la existencia del circuito oficial de suministro de las regiones más lejanas de frontera militarizada del Imperio lo que explicará la aparición de ánforas de tipo Dressel 20 en la costa occidental de la Península Ibérica. Tampoco se puede proponer una supuesta limitación ecológica a la presencia de olivos, una vez que se conoce bien la existencia de los olivares lusitanos y no faltan testigos de producción local de aceite de oliva. Por fin, hay que añadir que el volumen de información conocido se puede considerar mínimamente significativo, tanto para la *Britannia*, como para la costa *Lusitana*.

En este caso y una vez que se está comentando el ambiente de circulación de alimentos en la *Lusitania*, es interesante notar que, contrariamente a lo observado con los vinos itálicos y galos, el aceite de oliva de la Bética presenta un panorama de dispersión bien distinto. En *Olisipo*, las ánforas béticas de tipo Dressel 20 son abundantes, al igual que sus sellos (Almeida: Filipe, 2013: p. 742; Fabião *et al.*, 2016: p. 33-83). Pero este fenómeno no se verifica en la capital provincial *Avgvsta Emerita* (Almeida; Sánchez Hidalgo, 2013: p.52), donde son escasas las ánforas de este tipo y casi desconocidos los sellos – un solo ejemplar registrado (Fabião *et al.*, 2016: p. 57-58). Curiosamente, en la capital provincial se documentan ejemplares de la llamada Dressel 20 *parva* (Almeida; Sánchez Hidalgo, 2013: p.56), también bien representadas en *Olisipo* y en otros lugares de *Lusitania* (Fabião *et al.*, 2016: p. 119). Esto será quizás un interesante tema para futuras investigaciones pues podrá relacionarse con distintos ámbitos de difusión, tanto en plan regional, como en plan económico. Con ello, quiero sugerir que es posible que el formato canónico de la Dressel 20 sea utilizado para el transporte a larga distancia, mientras que las *parvae* se destinarían a circuitos de proximidad. Otra posibilidad es que las ánforas de dimensión normal se destinaran a los transportes institucionales y que el pequeño módulo se destinara al mercado.

Trabajar con este tipo de fuentes es sumamente importante para documentar presencias, pero comporta siempre el problema de cómo interpretar las ausencias. Un ejemplo, una vez más basado en la evidencia de *Lusitania*. En su estudio sobre la distribución de las ánforas Dressel 20 con el sello CANTONIQVIETI, U. Ehmig señala la densa presencia de estos sellos en Roma, al igual que en la *Britannia*, *Galliae* y *Germaniae*, subrayando su ausencia en otras áreas de la Península Ibérica, con la excepción del valle del Guadalquivir. El mapa de distribución es muy expresivo e indica claramente los principales circuitos de distribución (Ehmig, 2003: p. 110, karte 2). Sin embargo, falta en este mapa el ejemplar ya conocido y publicado de la *villa* de Pisões, cerca de *Pax Ivlia* (Fabião, 1993-1994: p. 236; véase el mapa de la *Lusitania* para localizar *Pax Ivlia*). Por su localización francamente interior, este ejemplar indica una nueva área de dispersión occidental que enriquece el panorama dibujado, sugiriendo nuevas rutas y direcciones que la carta presentada no registra. Al tratarse de un ejemplar procedente de una *villa* sin acceso directo al litoral su presencia implica necesariamente un lugar de importación directo y un circuito de redistribución, por lo menos, desde el lugar de importación. El futuro desafío será identificar el circuito en sí mismo, algo que solamente el crecimiento de la información podrá propiciar, atendiendo a la escasa representación de ánforas Dressel 20 en la capital provincial ya indicada. Es de esperar que la investigación en curso de Rui Roberto de Almeida, en el ámbito de su tesis doctoral, sobre la distribución de las ánforas del Guadalquivir en *Lusitania* pueda aclarar algunas de estas cuestiones.



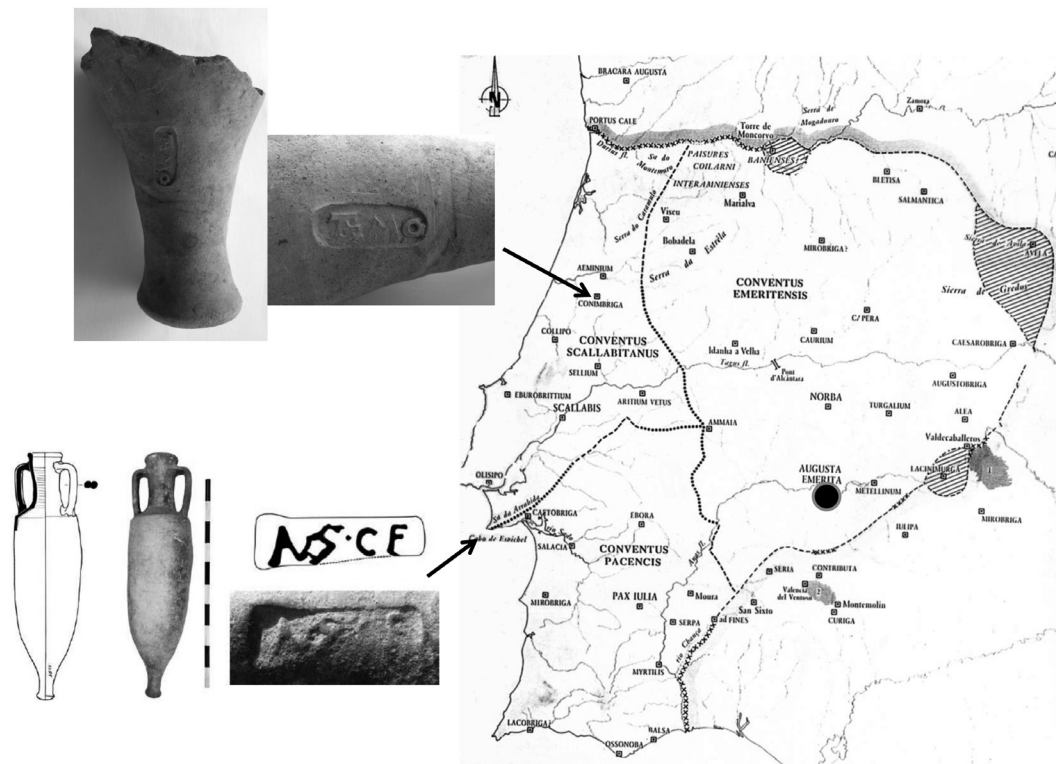
Un último ejemplo parece interesante. En los recientes inventarios de dispersión de los sellos de ánforas africanas en el Imperio Romano, se documentan escasísimos hallazgos occidentales (Stone, 2009). En su artículo D. L. Stone insiste en la significativa presencia de las marcas africanas en los circuitos annonarios y también en las islas mediterráneas occidentales, registrando, simultáneamente, la ausencia de estos sellos africanos o incluso de vestigios de presencia de ánforas de esa procedencia en los sitios militares (*Idem*: p. 141-142). Recientemente, hemos publicado algunos sellos africanos aparecidos en Tróia, en la desembocadura del río Sado, y en el Algarbe, procedentes de *Hadrumentum* y de *Leptiminus* (Fabião *et al.*, 2016). Estos hallazgos constituyen el documento más occidental del tráfico de ánforas de origen africana (véase mapa de la Figura 5). Estos hallazgos occidentales confirman de algún modo lo ya sugerido por Stone, que además de los circuitos institucionales y locales (dentro de la misma provincia de la *Byzacena*), también hubo un mercado interprovincial de difusión y consumo de estos alimentos africanos. Aunque escasos, los sellos africanos de *Lusitania* asumen particular interés al documentare una nueva área de distribución, más occidental, anteriormente insospechada. La verificación de que estos sellos no se registran ni en la *Britannia* ni en la *Germania Inferior* sugiere que la *Lusitania* sería en sí misma un destino final y no solamente un lugar de paso para suministros que se dirigían a otros parajes. Es una situación similar a la comentada en relación al aceite bético, ya que los sellos no documentados en parajes más septentrionales demuestran la condición de efectivo destino final de los puertos lusitanos.

Los ejemplos mencionados pertenecen al ámbito del registro de sellos sobre ánforas y no hay duda de que el material sellado sería siempre minoritario en relación al número total de ánforas producido y exportado. Así, un nuevo dominio de estudio pasa, en el futuro (creo) por la cuantificación de las ánforas selladas o no selladas, a partir de los conjuntos procedentes de excavaciones modernas y con información tratada de un modo sistemático. Este tipo de análisis es posible gracias al cambio del paradigma en el estudio de las ánforas romanas que ha supuesto la valoración particular de las características petrográficas de las pastas, frente a las simples morfologías, propiciada por la obra de D. Peacock y D. Williams (Peacock; Williams, 1986). Un primer paso importante se dio con el cruce entre la base de datos de CEIPAC con el *website* del Proyecto *Amphorae* de la Universidad de Southampton - [http://archaeologydataservice.ac.uk/archives/view/amphora\\_ahrb\\_2005/](http://archaeologydataservice.ac.uk/archives/view/amphora_ahrb_2005/). El paso siguiente será la inclusión en la base de datos CEIPAC de la información sobre ánforas no selladas registradas en los sitios arqueológicos de procedencia de los sellos, algo que ya recogen varias entradas de dicha base.

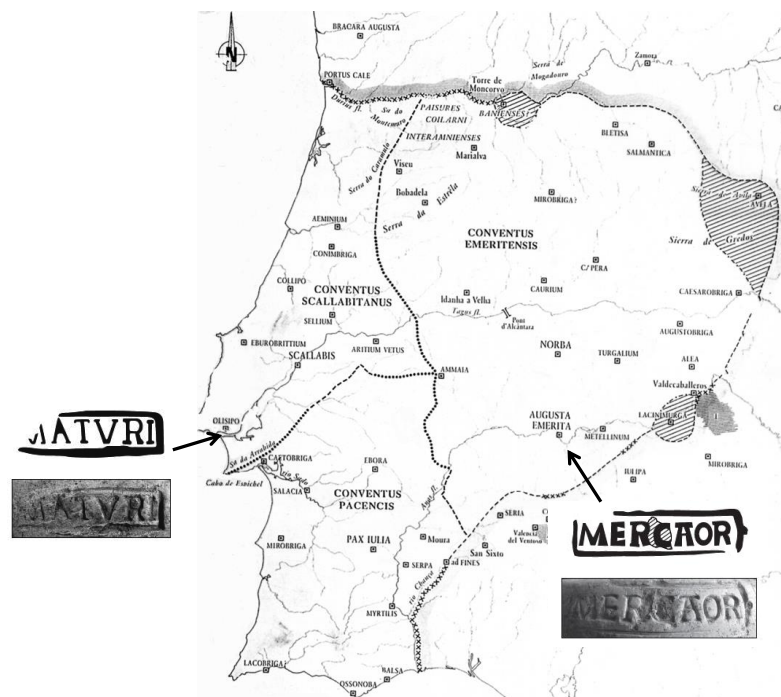
Resta una última cuestión. En la investigación se ha hecho habitual la utilización del concepto de Globalización en las Ciencias Sociales para definir los amplios y complejos fenómenos económicos del pasado. Lo mismo ocurre con el mundo antiguo donde la palabra clave en la bibliografía anglo-sajona, que suele ser la principal referencia internacional, es actualmente *Connectivity* (una referencia estrictamente asociada a esa noción de globalización). Este concepto subyace, como elemento central de investigación, en las interdependencias provinciales, advertidas y registradas en el ámbito de la base de datos del CEIPAC. Una prueba más de cómo ha sido pionero el Proyecto que hoy día sigue construyendo las bases (las fuentes, diría) para el estudio de esa misma interconexión que generaba una amplia escala de intercambios en el Imperio Romano.

El objetivo final sigue siendo, como siempre, el más básico de la investigación histórica: la *quellenforschung*, o sea, el establecimiento crítico de nuestras fuentes y el diseño de las mejores estrategias para alcanzar este fin. En ese ámbito, hoy como ayer, el CEIPAC sigue una trayectoria constante.

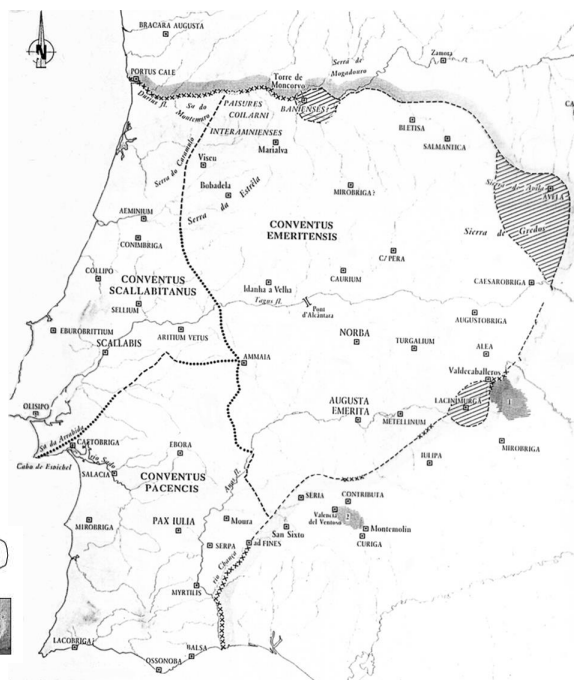
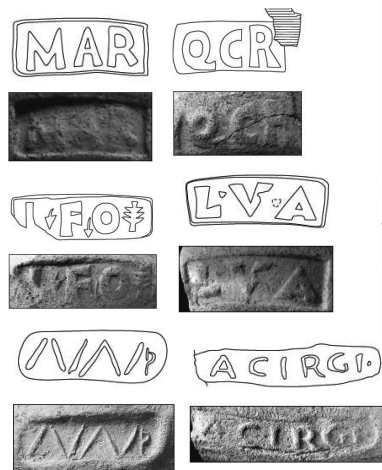
## FIGURAS



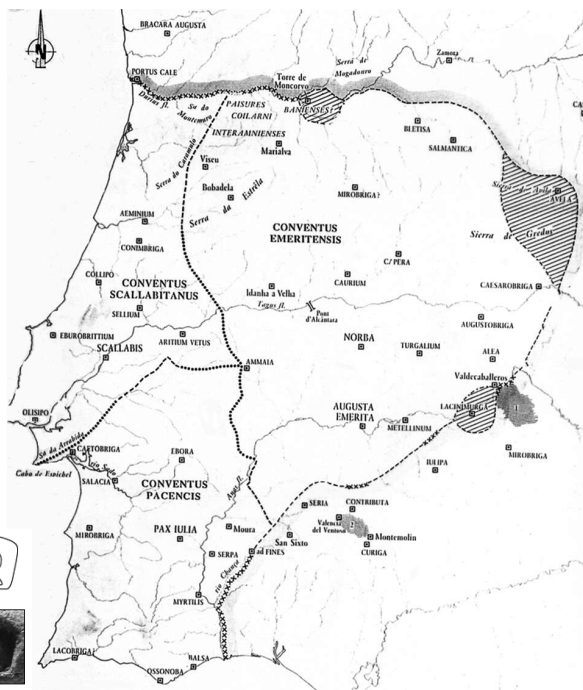
**Fig010** Mapa de la presencia de sellos sobre ánforas tirrénicas del tipo Dressel 2-4 en el occidente de Lusitania: hallazgo subacuático (Cardoso; Rodrigues, 2016); sello de Conimbriga por amable información de Ida Buraca.



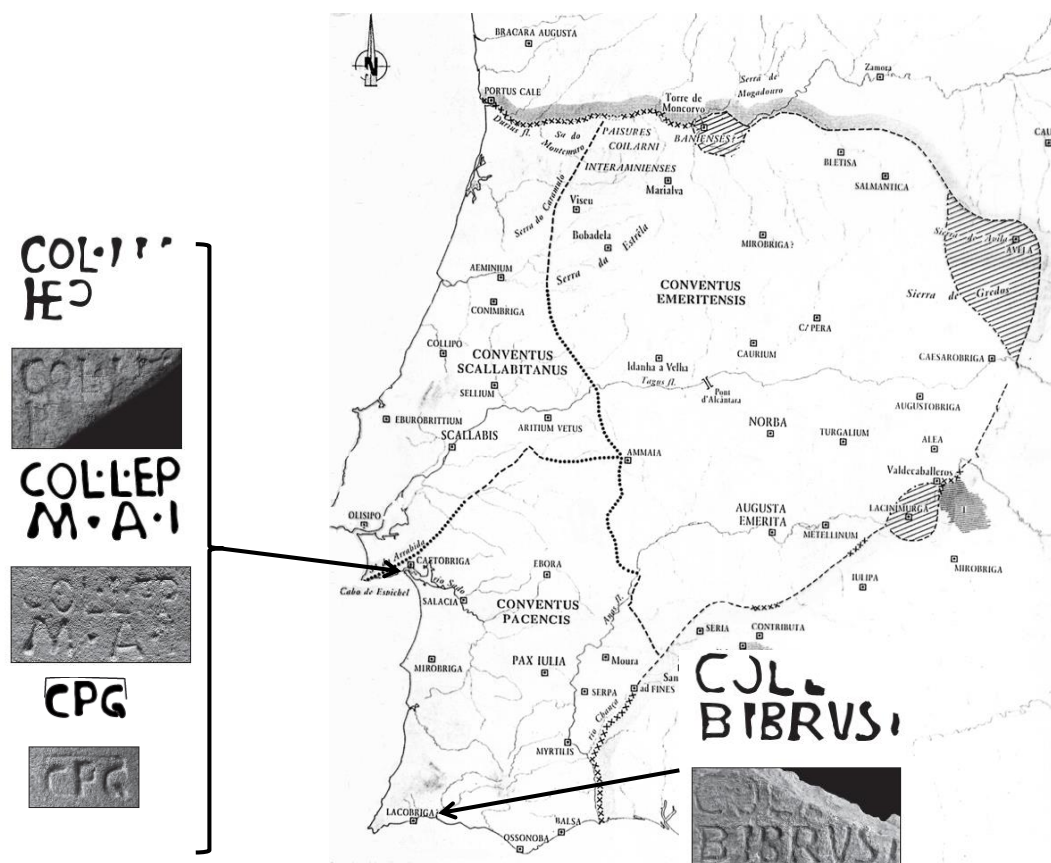
**Fig020** Mapa de la presencia de sellos sobre ánforas galas (Fabião et al., 2016).



**Fig030** Ejemplos de sellos sobre ánforas Dressel 20, de muy larga diseminación y representados en la Britannia (Fabião et al., 2016).



**Fig040** Ejemplos de sellos desconocidos en las regiones septentrionales y poco documentados en otras regiones del Imperio Romano (Fabião et al., 2016).



**Figura 5. Algunos sellos sobre ánforas africanas en el litoral lusitano (Fabião et al., 2016). La base cartográfica de la Lusitania romana es la que fue dibujada en el ámbito de la mesa redonda de Talence (1988).**

**VV AA (1990) *Les Villes de Lusitanie romaine: hiérarchies et territoires : table ronde internationale du CNRS, Talence, le 8-9 décembre 1988*. Paris: Ed. CNRS.**

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## THE DEBATE ON THE ANCIENT ECONOMY AS A “BATTLEFIELD” AND THE QUESTION OF TRANSPORT ROUTES TO THE RHINE REGION<sup>1</sup>

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In 1983, Keith Hopkins described scholarly research into the ancient economy as an “academic battlefield”.<sup>2</sup> Specifically, he was referring to the Bücher-Meyer controversy, a still on-going dispute between “primitivistic” and “modernistic” interpretations of the ancient economy.<sup>3</sup> In 1893, Bücher, an economist<sup>4</sup>, published his well-known work on the emergence of national economies, in which he described the ancient economy as a form of closed domestic economy. Both production and consumption of economic goods, according to Bücher, took place in the context of an *oikos*-economy. He saw autarky as the main goal of ancient economic activity and emphasized the differences between this and modern economies, developing a chronological model of economic development: ancient *oikos*-economy was followed by mediaeval city-economies and finally modern national economies.

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<sup>1</sup> I wish to thank José Remesal-Rodríguez for inviting me to the very stimulating conference in Barcelona and his acceptance of this paper for publication. Thanks are also due to Katja Krell, Armin Becker, Patrick Reinard and Tom Decker for their help in preparing the paper, as well as to Christian Rollinger for translating it.

<sup>2</sup> HOPKINS 1983, IX.

<sup>3</sup> The relevant works by Karl Bücher and Eduard Meyer are printed in FINLEY 1979; on the debate see also TSCHIRNER 1994, 22ff.; SCHNEIDER 1990; SCHNEIDER 1999; DREXHAGE/KONEN/RUFFING 2002a, 19f.; DREXHAGE/KONEN/RUFFING 2002b, 1-5; RUFFING 2008a, 1ff.; SCHNEIDER 2009; WAGNER-HASEL 2009; RUFFING 2012, 8f.

<sup>4</sup> On Bücher, see RUFFING 2008a, I 1; WAGNER-HASEL 2011, 315ff.; WAGNER-HASEL 2013.



This position was greeted with much skepticism by scholars of ancient history, though it was influential in giving rise to the so-called “primitivistic” interpretation. In 1895, Eduard Meyer took a very different view, emphasizing in turn the “modernity” of the ancient economy. According to this view, trade, especially maritime trade, played an immense part in ancient economic activity, and this was reflected in sources as early as the writing of Hesiod. Trade then, according to Meyer, was the main source of income and wealth in the ancient world, and Meyer thus founded what was to become the “modernistic” view. The antipodes of “primitive” and “modern” were to be the two main leitmotifs of academic research into the ancient economy for the next century.

Along with Meyer, Ulrich Wilcken also argued against the primitivistic view in 1899, and strongly emphasized the need to include analysis of documentary evidence, i.e. papyri and *ostraka* of a mainly Egyptian provenance, in any future reflection on the ancient economy.<sup>5</sup>

The works of Michael I. Rostovtzeff provided the next marked advancement in academic research on the ancient economy. In 1926, he published his *Social and Economic History of the Roman Empire*, which, translated into a number of languages and reprinted in a second edition in 1957, was to have a profound impact on the discussion, as did his follow-up work on the *Social and Economic History of the Hellenistic World*, published in 1941.<sup>6</sup> But it is his interpretation of the economic history of the Roman empire that is of the greatest interest here.<sup>7</sup> According to Rostovtzeff, the urban citizen-elite – the bourgeoisie, in his own anachronistic terminology – progressively became decoupled from the great mass of the Roman citizenry, which in turn led to an estrangement between the urban and rural populations. This increasing estrangement came to a head during the crises of the 3<sup>rd</sup> century AD, as for instance in Rostovtzeff’s interpretation of the events of AD 238 as an exemplary conflict between urban and rural populaces in northern Africa. This crisis was responsible for destroying social consensus and coherence, which in turn led to the introduction of a form of ‘oriental’ despotism within the Roman empire.

On an economic level, Rostovtzeff acknowledged that developments within the Principate were conducive to the development of a rapid and successful economic development based on trade, industry, and agrarian production. The high degree of urbanization within the empire should be seen as an indication of this. This development had started earlier during the Hellenistic age, which had also seen an increase in agrarian production and trade, as well as a high degree of economic activity aided by a developing tertiary sector. Thus, for Rostovtzeff the Hellenistic economy was a form of capitalism, differing from its modern equivalent only in quantity, not in quality. The development of this ancient capitalism reached its peak during the Roman empire, at which point undesirable trends also started to surface. The greatest economic burden fell on the shoulders of the rural population, which in turn led to the estrangement between city and hinterland mentioned before.

In summary, Rostovtzeff firmly came down on the side of the “modernists”. But what made his contributions to the investigation of the ancient economy so remarkable (even if some of his

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<sup>5</sup> Wilcken was to repeat this plea in 1912.

<sup>6</sup> Rostovtzeff, along with M. I. Finley, is among the most debated scholars of the ancient economy; on his biography and work, see CHRIST 1972, 334ff.; HEINEN 1993; HEINEN 2006; SCHNEIDER 2012a; Manning 2015, on purely biographical matters also WES 1990 and KREUCHER 2005, 1ff. A collection of papers published by Jean ANDREAU in 2008 is also especially helpful. Rostovtzeff, who emigrated from Russia in 1920, was himself very aware of the impact of his own checkered biography on his work; cf. ROSTOVITZEFF 1957, 495.

<sup>7</sup> Cf. RUFFING 2008a, 2f.

interpretations and conclusions can rightly be doubted<sup>8</sup>) was not only the fact that he produced comprehensive overviews of individual historical periods, but his use of all and any available sources, including archaeological and papyrological evidence.<sup>9</sup> On the other hand, his idiosyncratic application of modern terminology (such as “bourgeoisie” and “capitalism”) to the ancient world was and is highly debatable.<sup>10</sup> Among those who rigorously objected to such an anachronistic use was Johannes Hasebroek, who published two important studies on the archaic and classical Greek economy in 1928 and 1931 respectively.<sup>11</sup> Like Bücher (and against the likes of Meyer and Rostovtzeff), he argued for an economy generally limited to the *oikos* at a subsistence level (or only very slightly above it), despite very early evidence for commerce-driven seafaring. Also, like Bücher, he perceived radical differences between the ancient and modern economies, describing the inhabitant of the ancient world as primarily a *homo politicus*, as opposed to the *homo oeconomicus* at work during the Middle Ages and the modern period. It should be noted, however, that Hasebroek explicitly limited his conclusions to the pre-Hellenistic period. He did not produce an analysis of later periods.

In 1933, Tenney Frank embarked on a seminal project, the *Economic Survey of Ancient Rome* (ESAR). It aimed not at producing another overall analysis of the Roman economy, but rather on providing the fundamentals for such an undertaking, i.e. a broad and systematic source foundation. The results of his work were published in five considerable volumes (plus an index volume), which provided – and still provide – an exceptionally long-lasting and impactful research tool in the tradition of Wilcken’s and Rostovtzeff’s approach.

The next scholar to produce an overall analysis of the ancient economy was Fritz Moritz Heichelheim in 1938. Heichelheim published a truly impressive work stretching from the Paleolithic to early Byzantium under emperor Heraclius. He side-stepped a firm commitment to either the “primitivistic” or “modernistic” view, but instead tried to capitalize on the methodologies and terminologies of national economics and on the works of the political scientist and sociologist Arthur Spiethoff, whose economic categories (household – city – country – national economy) he adapted. He postulated the development of a form of urban economy, which Bücher had only accepted for the Middle Ages, as early as the 6<sup>th</sup> century B.C. More than that, the economic connections between Hellenistic economic and political centres showed characteristics of later national economies, but their development was interrupted by the coming of Rome and the extinction of the Hellenistic states. Contrary to Rostovtzeff, Heichelheim thought the Roman empire to be a considerable setback in economic terms, as the Romans neglected to create a unified economic space. He did not, however,

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<sup>8</sup> Thus, the economic crisis of the 3<sup>rd</sup> century is nowadays seen as having had less of an impact than Rostovtzeff would have us believe; cf. RUFFING 2006 and RUFFING 2008b, with JOHNSON 1936, 303f.; RATHBONE 1991 and DREXHAGE 1991, 440ff. Likewise the social conflicts of that century have recently been reconsidered, cf. SANGER 2011, 37ff.

<sup>9</sup> His emphasis on papyrological evidence is manifest not only in his main studies, but also in smaller works, i.e. on Hellenistic Egypt or on Roman tesserae; cf. Rostovtzeff 1905; 1922.

<sup>10</sup> His first use of the term “capitalism” was in a study originally published in 1900, but which was only made accessible to a larger audience in 1987; cf. ROSTOVITZEFF 1987 together with ANDREAU 1987. On his terminology, see also MEIKLE 2002, 239f.

<sup>11</sup> See also HASEBROEK 1923.

subscribe to the main arguments of the “primitivistic” view, which experienced its next revolution almost 80 years after Bücher’s original publication.

In 1973, Moses I. Finley<sup>12</sup>, heavily influenced by Max Weber and Karl Polanyi<sup>13</sup>, published his seminal work “The Ancient Economy”, which was later reprinted in an expanded second edition in 1985 and translated into a number of other languages.<sup>14</sup> Finley’s work was especially influential among Anglophone academics and he emerged as the founding figure of what came to be known as the “neo-primitivistic” school.<sup>15</sup> Like Hasebroek before him, Finley objected to the use of modern terminology for ancient economics and asserted that the ancient languages did not have words for abstract concepts such as “the economy” or “the market”. Indeed, from a cultural perspective, the ancient world valued trade and economics completely differently, with the elites consisting mostly of owners of large farms and agrarian complexes, and artisans and traders ranging decidedly lower on the social scale. Indeed, to Finley’s mind, social status was inextricably linked to economic activity and ‘menial’ occupations such as trade and crafts did not provide their practitioners with any social capital. The ancient economy as a whole was based on slave labour, with ancient society in general being a slaveholding society. As far as the development of the agrarian sector is concerned, Finley argued that ancient farming only surpassed pure subsistence farming with the beginning of the Roman empire and denied the existence of ‘markets’, with the exception of a number or smaller, regional markets in rural regions. This notwithstanding, Finley’s ancient economy is one centered on the tenet of self-sufficiency, which, in turn, was one of two major contributing factors to the lack of technological innovation in the ancient world (the other being the availability of slave labour). For him (as for Max Weber), the ancient city was a parasite, consuming the fruits of others’ labour. With overland trade being exceedingly inefficient, only maritime trade/transport was even realistically feasible, though he thought any export trade negligible. Like Rostovtzeff, Finley discerned a steady growth of Roman cities, though he denied that this coincided with any significant improvement in production or export trade. He also denied that ancient Greeks or Romans conceptualized or theorized the economy as an abstract notion and thus also denied any conscious economic policy on the part of ancient states. Taxes and tariffs served as means of income, not of economic control. In short, Finley categorically denied any ancient notion of ‘economics’.

A fair criticism that has been levelled against this “neo-primitivist” view (by Henri Willy Pleket<sup>16</sup> among others) is that, while it is very explicit in stating what the ancient economy was *not*, it neglects to present a coherent view of what it actually *was*. Finley’s conclusions were nevertheless warmly received by a large part of the academic audience, though it should be mentioned that he confined his analyses mostly on pre-Hellenistic Greece and republican and early imperial Rome, with the cities of Athens and Rome the undoubted overall focus. Finley’s most long-lasting contribution was the notion of an embedded economy,<sup>17</sup> which, together with the effects of slave labour, received

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<sup>12</sup> On Finley, see CHRIST 1990, 295ff.; SHAW 1993; TSCHIRNER 1994; ANDREAU 2002, 33-36; EICH 2006, 42ff.; SALLER 2013; REBENICH 2013, 630ff.; SCHNEIDER 2012b.

<sup>13</sup> On the influence of Weber and Polanyi, see TSCHIRNER 1994, 45ff. and 128ff; NAFISSI 2005; BRESSON 2007, 14ff; on Max Weber himself, see also CAPOGROSSI COLOGNESI 2009.

<sup>14</sup> FINLEY 1999; FINLEY 1993.

<sup>15</sup> For a general overview of Finley’s analysis, see RUFFING 2008a, 6-10.

<sup>16</sup> PLEKET 1990, 32ff.; JACQUES/SCHNEID 1998, 320.

<sup>17</sup> See now CARLÀ/GORI 2014.

much attention in a 1972 study by Michel Austin and Pierre Vidal-Naquet on the economy and society of ancient Greece.<sup>18</sup>

In 1976, Thomas Pekáry published an introduction to the ancient economy to wide acclaim.<sup>19</sup> Like Finley, Pekáry cautioned against an all-too modern interpretation of the ancient economy, but unlike the latter, he also advised against an overly schematic adaptation of economic models. In contrast, he pointed to a vast trove of source evidence hitherto neglected by academics. Indeed, most of what might be termed the “primitivistic” school had almost exclusively used literary evidence in their analyses.<sup>20</sup> Like Wilcken, Rostovtzeff, or indeed the ESAR project, Pekáry argued in favor of including other sources.<sup>21</sup> Another essential element of his approach, however, was to point out that no general economic structures existed throughout the whole of the ancient Mediterranean. There was, in short, no single ancient economy and thus generalized reflection on “the” ancient economy could be nothing but fruitless.

Francesco De Martino, in an economic history of Rome published in 1979, argued against the “modernist” school.<sup>22</sup> He rejected the notion of “capitalism” in the ancient world and stressed the technological backwardness of ancient cultures, while at the same time arguing against Finley’s embedded economy and his assertion that an ancient market economy did not exist. Even while postulating a fundamentally *oikos*-economy for archaic Rome, De Martino saw a clear development with the Augustan age at the latest, which saw a sharp increase in trade and production. Like Rostovtzeff, De Martino published a general overview of Roman economic history which examined the whole of Roman history and did not limit itself to the high empire. In general, De Martino acceded to neither of the two dominating schools of thought, and instead came to his own conclusions which were more mediatorial.

Hopkins’ 1983 study, from which the introductory quote was taken, on the other hand asserted that Finley and A.H.M. Jones<sup>23</sup> had formulated a new scholarly consensus on the subject of the ancient economy, which he himself enthusiastically subscribed to. Hopkins firmly rejected any “modernist” inclination and instead asserted that any closed regional entities in antiquity were economically determined by the quest for self-sufficiency. Thus, no supra-regional trade existed, and thus there was no specialized production in urban centres, no export trade, and no consumer market. Hopkins and his followers in what came to be called the Cambridge School<sup>24</sup> thus hewed closely to Finleyan orthodoxy.

On the other extreme, Fernand Braudel argued in 1986 that self-regulating markets existed in the Hellenistic period and that “capitalist” was in fact an appropriate moniker for the Hellenistic and Roman imperial economy. Generally, the 1980s saw a steady increase in researchers and scholars rejecting individual tenets (or the whole) of the “primitivistic” school. One influential scholar was Herbert Graßl, who in 1982 showed that Greek authors of the Roman empire included specifically economic themes and motifs in their works. Graßl was instrumental in pointing economic historians

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<sup>18</sup> AUSTIN/VIDAL-NAQUET 1984.

<sup>19</sup> RUFFING 2008a, 10; cf. PEKÁRY 1994.

<sup>20</sup> RUFFING 2015, 4.

<sup>21</sup> Cf. also the well-received study of the financial business of Jucundus by Jean Audreau in 1974.

<sup>22</sup> DE MARTINO 1985; cf. RUFFING 2015, 4f.

<sup>23</sup> Jones had already expressed his support for the “primitivistic” views in his 1964 monumental study of Late Antiquity.

<sup>24</sup> RUFFING 2015, 3.



in the direction of heretofore neglected literary source material.<sup>25</sup> The same year also saw the founding of the first and hitherto only academic journal explicitly devoted to research on the ancient economy: the “*Münstersche Beiträge zur antiken Handelsgeschichte*”, rechristened in 2009 as the “*Marburger Beiträge zur antiken Handels-, Sozial-, und Wirtschaftsgeschichte*” (MBAH). Founded by Hans-Joachim Drexhage, this publication specializes in publishing detailed studies and analyses of economic history, with a special regard to the utilization of papyrological and epigraphic evidence. If the bipolar dispute between “primitivists” and “modernists” was, to a certain extent, overcome (or at least moderated) in recent years by the inclusion and assessment of considerable new evidence, the MBAH have contributed to this in no small fashion.

Indeed, significant advances have been made in bridging the gap between “primitivists” and “modernists” in recent decades. One contribution to this was made by the aforementioned Henri Willy Pleket, who published a number of important works on the Roman imperial economy throughout the 1980s.<sup>26</sup> In those, he adapted a comparatistic approach and examined the Roman imperial economy in regard to other pre-industrial economies. Thus he was able to show appreciable overlaps between the Roman and certain early modern economies which militated against the “primitivist” view.

In 1991, Dominic Rathbone and Hans-Joachim Drexhage each presented research which dramatically showed the potential gains to be derived from the inclusion of papyrological evidence in analyses of the Roman economy.<sup>27</sup> Rathbone had already earlier criticized the continued focus of the “primitivist” school on a small selection of literary texts to the exclusion of archaeological and other evidence.<sup>28</sup> Drexhage’s important work on prices, wages, and rents in Roman Egypt led to the establishment of a database which then served to reconstruct a hypothetical ratio between prices and wages for parts of the Roman empire. This allowed for a contextualization of the large number of monetary sums mentioned in literary sources. Thus, for the first time, monetary and economic figures within our sources could now be examined in regard to their real-life implications.

Hans Kloft was the next scholar to abandon primitivism in 1992, when he developed new positions independent of the neo-primitivist orthodoxy, similar to the mediatory approach taken earlier by De Martino. A decade later, Kloft was able to identify connections between the micro and macro economic levels while referring to the economics “stiles” introduced by Heichelheim.<sup>29</sup> His innovative studies served as a template for an intermediary avenue of research, potentially bridging the gap between Finley’s general models of economic activity and Rostovtzeff’s and Drexhage’s detailed source studies.

William V. Harris also argued against the stark schematism of the primitivist school in 1993, which he proposed to replace with a dynamically changing model of economic development under the Roman empire.<sup>30</sup> In addition, he also argued for the existence of interdependent markets in antiquity, which were responsible for the exchange of goods. These hypotheses were published in conference proceedings which were eager to bring together economic historians, and epigraphic and

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<sup>25</sup> GRASSL 1982.

<sup>26</sup> PLEKET 1984; PLEKET 1988; PLEKET 1990; cf. RUFFING 2015, 6.

<sup>27</sup> RATHBONE 1991; DREXHAGE 1991; see also KEHOE 1992.

<sup>28</sup> RATHBONE 1989, 160f.; see also RUFFING 2015, 5. Important papyrological studies (SCHNEBEL 1925; MICKWITZ 1965; see also the bibliography in RUPPRECHT 1994, 179ff.) had been published throughout the 20<sup>th</sup> century, but they did not have a significant impact on the discussion of ancient economic history until the 1990s.

<sup>29</sup> KLOFT 2002.

<sup>30</sup> HARRIS 1993a; HARRIS 1993b.

archaeological evidence of economic activity. Like Rathbone, Drexhage, and Kehoe, Harris was able to aggregate new evidence in order to produce new knowledge.

Generally, the 1980s saw a much higher degree of inclusion of archaeological evidence in economic histories.<sup>31</sup> In 1986, André Tchernia published his study of Italian viticulture which rested mostly on his interpretation of *amphorae* finds.<sup>32</sup> The same year also saw the publication of the first volume of Stefanie Martin-Kilcher's work on the *amphorae* from Kaiseraugst (the second volume was to follow in 1994).<sup>33</sup> The work of José Remesal-Rodríguez was likewise of fundamental importance to the development of this sub-field of economic research.<sup>34</sup> His research on the correlation of amphorae and their inscriptions, which has rightly been called "pioneering" in a recent publication, was especially notorious.<sup>35</sup> Of the body of his research into ancient *amphorae*, particular mention must be made of his study of the Monte Testaccio *amphorae* (CEIPAC), as well as his monograph on the Dressel 20-type *amphorae* in Germany and the *Baetica*.<sup>36</sup> Ulrike Ehmig was likewise an influential researcher in this field, to whom particular credit must be given for pioneering the scientific analysis of *amphorae* and the advantages of this for economic research.<sup>37</sup>

A decade after the boom in *amphorae* studies, Terra Sigillata remains were also 're-discovered' for the purposes of economic history, with Gunnar Fülle publishing a number of studies from 1997 onwards, dealing with the organization and logistics of pottery workshops in Arezzo and La Graufensenne.<sup>38</sup> Proceedings from a conference organized by Karl Strobel in 2000 further reinforced the importance of this avenue of research.<sup>39</sup> Based on this newly-available evidence, Strobel argued against the still predominating neo-primitivist view and in favor of overcoming the by now century-old divide between primitivists and modernists. He advocated a closer analysis of the market and profit orientation of ancient economic actors, of the use of natural and human resources, as well as manufacturing processes<sup>40</sup>, and identified the steady juridification of economic activity during the Roman empire as a fundamental aspect of Roman economic history.<sup>41</sup>

Michel Polfer arrived at very similar conclusions via a very different approach. As initiator of the CRAFTS project, Polfer contributed important studies on Roman artisanry and craftsmanship. While he agreed with the primitivists that ancient economic structures inherently differed from modern ones<sup>42</sup>, he nevertheless recognized in ancient economic actors fundamentally 'modern' aspects, such as profit orientation and the existence of targeted production for superregional markets. The works of Strobel and Polfer serve to show how much progress has been made in recent years in overcoming the outworn argument between primitivists and modernists by opening new avenues of enquiry and by incorporating and analyzing significant papyrological and archaeological evidence into their research. A decade after Polfer, Nicolas Monteix and Nicolas Tran published their own

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<sup>31</sup> Cf. RUFFING 2015, 7f.

<sup>32</sup> TCHERNIA 1986.

<sup>33</sup> MARTIN-KILCHER 1987; MARTIN-KILCHER 1994a. See also MARTIN-KILCHER 1994b, an important methodological contribution to *amphorae* studies.

<sup>34</sup> Cf. RUFFING 2015.

<sup>35</sup> RUFFING 2015, 7.

<sup>36</sup> REMESAL-RODRÍGUEZ 1997.

<sup>37</sup> EHMIG 2003; EHMIG 2007a.

<sup>38</sup> FÜLLE 1997; FÜLLE 2000a; FÜLLE 2000b.

<sup>39</sup> STROBEL 2000a.

<sup>40</sup> STROBEL 2000b.

<sup>41</sup> The importance of this aspect was later also emphasized by LO CASCIO 2005; LO CASCIO 2006; KEHOE 2007.

<sup>42</sup> POLFER 2001a; POLFER 2001b; cf. also POLFER 1999.

collection of essays dealing with Roman craftsmanship and a regional focus on the Vesuvius region<sup>43</sup>. In this publication, primitivist views were completely eschewed and authors instead focused on new approaches derived from modern structural history.

The increasing openness of economic historians is by no means limited to archaeological evidence; indeed, a plurality of different research paradigms has developed since the 1990s, with each paradigm incorporating a variety of different source materials and methodological innovations. This development was extremely fruitful in that it opened the academic discussion of ancient economies and transcended the old argument between modernists and primitivists. With these new approaches there was no longer an absolute need to support either view, since “the” ancient economy *in toto* was no longer the focus of research. Instead, scholars concentrated on individual aspects, such as legal history,<sup>44</sup> individual economic sectors,<sup>45</sup> or discrete economic regions.<sup>46</sup>

The last one and a half decade also saw new theoretical approaches being tried and adapted, with *Transaction Cost Theory* and *New Institutional Economics (NIE)* being among the most prominent.<sup>47</sup> NIE in particular opened new perspectives for historical research into the ancient economies, especially when combined with research into social history, as in the case of *Principal Agent Theory*. Even though these approaches were sometimes highly theoretical and formalized models, their application within the field of ancient history was much less schematic than might have been expected. On the contrary, they opened up the field like never before and this new openness manifested itself in a variety of new research: Peregrine Horden and Nicholas Purcell showed the importance of regional connectivity for economic activity.<sup>48</sup> Heichelheim’s economic “styles” were adapted by Detlev Landmesser.<sup>49</sup> Ulrich Fellmeth has emphasized the importance of locational factors in agrarian production and re-interpreted the traditional Thünen model.<sup>50</sup> Neville Morley has on the other hand argued persuasively that the new controversy between formalists and substantivists is largely due to a misunderstanding of economist theory.<sup>51</sup> Ken Dark has identified a form of proto-industrialization under the Roman empire.<sup>52</sup> Peter Fibiger Bang, adapting (somewhat unconvincingly) the comparatistic method of Pleket, has compared the Roman economy with the Indian one of the Mughal Empire.<sup>53</sup> In recent research, Heribert Graßl has identified characteristics of ancient economic activity since the 6<sup>th</sup> century B.C. which could appropriately be said to indicate the existence of a market economy.<sup>54</sup> In 2013, Peter Temin agreed with this assessment in his monograph on “*The Roman Market Economy*”.<sup>55</sup> The dynamic development of the Roman economy, already identified in the works of Rostovtzeff and De Martino, has also been at the centre of recent research, particularly in the chapters of the 2007 “*Cambridge Economic History of the Greco-Roman World*”.<sup>56</sup>

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<sup>43</sup> MONTEIX/TRAN 2011.

<sup>44</sup> E.g. JAKAB 1997; SCHÄFER 1998; GÜNTHER 1998.

<sup>45</sup> E.g. RUFFING 1999; RUFFING 2008; DROSS-KRÜPE 2011.

<sup>46</sup> E.g. MORLEY 1996; JASCHKE 2010; HOLLERAN 2012.

<sup>47</sup> LO CASCIO 2005; LO CASCIO 2006; SCHMIDT 2014, 272ff.; RUFFING 2012, 12f.; TERMIN 2013, 11f.; RUFFING 2015, 12f.; SOMMER 2013, 79ff. Transaction Cost Theory had previously first been utilized by Morris Silver in the 1980s (SILVER 1985); see also EICH 2006, 98ff. On the impact of modern economists on economic historians, see in particular: WARNING 2015, 31ff.

<sup>48</sup> HORDEN/PURCELL 2001.

<sup>49</sup> LANDMESSER 2002.

<sup>50</sup> FELLMETH 2002.

<sup>51</sup> MORLEY 2007.

<sup>52</sup> DARK 2001.

<sup>53</sup> BANG 2008; see also RUFFING 2010; RUFFING 2015, 18f.

<sup>54</sup> GRASSL 2004.

<sup>55</sup> TEMIN 2013; see also TEMIN 2001.

<sup>56</sup> E.g. JONGMAN 2007; LO CASCIO 2007.

This wide array of approaches is representative for a new kind of ancient economic history, as is the work of Alan K. Bowman and Andrew Wilson, which attempts to quantify the performance levels of the Roman economy.<sup>57</sup> While the warnings of Jones and Finley about the lack of statistically relevant material from antiquity should be borne in mind<sup>58</sup>, this new approach seems extremely promising, particularly as the research of Johnson, Drexhage, Rathbone, and Ruffing (on papyrological evidence), as well as of Remesal-Rodríguez, Martin-Kilcher, Polfer, Fülle, and Ehmgig (on archaeological evidence) have conclusively shown that, with appropriate diligence and methodological care, the fragmentary sources informing us of ancient economic activity do lend themselves to this kind of research, if strict methodological and thematic limits are set.

One could adduce a vast number of further studies and researchers of recent years to show that the century-old “battle” about the nature of ancient economies, while by no means settled, has nevertheless reached a new stage: formerly rigid fronts and oppositions have loosened and a number of core tenets of the neo-primitivist school have been conclusively refuted. Modern research in ancient economies is theoretically open and based on a wide and ever-increasing variety of source evidence, and in this, a significant advantage has been made.

To further illustrate this point, I will in the following focus on one particular aspect of the Roman economy, i.e. trade and transport, with a particular focus on the maritime facet of this aspect of Roman economic activity. Jones and Finley, as figureheads of the neo-primitivist school, have characterized overland transport as fundamentally inefficient.<sup>59</sup> Based on literary sources (e.g. Cato the Censor) and data extrapolated from Diocletian’s Edict on Prices, for instance, it has been asserted that the cost of one cargo of grain (of about 550 kg) would have doubled after transport across a distance of 500 kilometers. This has now been refuted by careful study of the remaining sources and a somewhat more positive picture of the capabilities and performance of overland transport has been drawn up.<sup>60</sup>

While maritime trade and transport was considered to be more efficient than overland transport by the neo-primitivists, the latter nevertheless argued that maritime trade was only rudimentarily developed. There was not sufficient source material to support rare deviations from this orthodoxy. In contrast to overland transport, maritime trade was not recorded extensively in the remaining papyri and *ostraka*, and can only be traced in epigraphic and literary sources. The vast number of shipwrecks discovered across the Mediterranean, while no doubt impressive and highly informative, do not easily lend themselves to quantifying analyses.<sup>61</sup> Recently, however, advances have been made which may lead to a further quantification of maritime trade: in 2005, Pascal Arnaud published an influential monograph on ancient Mediterranean sea routes.<sup>62</sup> Christina Wawrzinek produced an impressive database of archaeological remains of Roman river and sea harbors.<sup>63</sup> Wim Broekaert has previously published a prosopographical database of *navicularii* and *negotiantes*,<sup>64</sup> and Thomas Schmidts has recorded the actors and organizational facets of maritime trade in the northwestern provinces.<sup>65</sup> Pascal Warnking, finally, has very recently published a new take on the complicated

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<sup>57</sup> BOWMAN/WILSON 2007; see also ANDREAU 2002, 37ff.

<sup>58</sup> FINLEY 1987, 39ff.

<sup>59</sup> JONES 1964 II 841f.; FINLEY 1993, 148.

<sup>60</sup> POLFER 1991; DREXHAGE/KONEN/RUFFING 2002, 139f. See also ADAMS 2007.

<sup>61</sup> Cf., e.g., PARKER 1992.

<sup>62</sup> ARNAUD 2005.

<sup>63</sup> WAWRZINEK 2014, 129ff. and 194ff.

<sup>64</sup> BROEKAERT 2013.

<sup>65</sup> SCHMIDTS 2011.



problem of Roman sea trade and its contextualization within the economic history of the ancient world and the organizational and structural framework of the Roman empire. In combining modern nautical software and traditional source hermeneutics, and based on much of the aforementioned works of recent years, he accomplished a stimulating synthesis which may show the way forward.

In the following, I wish to show one further example of how new data and methodological approaches may be used to produce new insights. The on-going debate on the specific transport routes of the German olive oil trade provides us with an ideal testing ground for this.

Jean Rougé and André Tchernia have emphatically stated that the innumerable amphorae which were used to transport olive oil have been shipped from the *Baetica* across the western Mediterranean to Arles, where it was reloaded onto river barges and lighters and ferried upriver on the Rhône until they reached Lyon, from whence it was ferried further north by way of the river Saône. To bridge the gap between the Saône and Moselle rivers, the *amphorae* then had to be reloaded again and transported by cart across the roads leading to the Moselle river. Again changing to river scows, they were then transported on the Moselle and the Rhine until they reached their final destination.<sup>66</sup> José Remesal-Rodríguez and Michel Reddé, on the other hand, have argued for transport via the Atlantic route, with the amphorae reloaded onto scows and lighters somewhere in the Rhine estuary.<sup>67</sup> Both sides have recently re-stated their views, Remesal-Rodríguez in a 2010 article called “De Baetica a Germania” and André Tchernia in a 2011 monograph entitled “Les Romains et le commerce”. Also in 2010, César Carreras and Rui Morais have edited a voluminous collection of essays on the ancient economy and trade by way of the Atlantic Ocean, what they call the “Mar Exterior”. James Beresford’s monograph on the “Ancient Sailing Season” also devotes a chapter to the problem of seafaring on the Atlantic, though he does not add anything radically new to the discussion.<sup>68</sup>

The high amount of monetary capital that followed the legions and legionaries into the German provinces led to the development of strong economic zones along the Rhine, from which the indigenous population profited and which in turn led to strong migrational impulses from more southern regions. The growing populace of the frontier zones adapted aspects of the Roman legionary lifestyle, which included a strong demand for oil.

Where did the needed oil originate? The archaeological record of Mainz, where, for most of the first century, a number of legion was garrisoned (though from AD 93 onwards only the *legio XII Primigenia pia fidelis* remained), shows that early imports of olive oil were transported in *amphorae* of the Brindisi type from south Italy, with some *amphorae* of the Tripolitana-I/II type hinting strongly at additional imports from North Africa. Both of these types are attested in very low numbers (no more than 10). On the other hand, the extremely numerous Dressel-20 type *amphorae*—more than 1,500!—show that by far the greatest share of imported oil originated in the *Baetica*.<sup>69</sup> Similar findings in Cologne confirm this,<sup>70</sup> as does the fact that pickled olives were transported mainly in Haltern 70-type *amphorae* also typical for the *Baetica*.<sup>71</sup>

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<sup>66</sup> ROUGÉ 1966, 93ff. Tchernia 2011, 327.

<sup>67</sup> REMESAL-RODRÍGUEZ 1986, 78f. REMESAL-RODRÍGUEZ 2010, 147ff. REDDÉ 1979, esp. 487.

<sup>68</sup> BERESFORD 2013, 71; 211.

<sup>69</sup> EHMIG 2003, 26ff.

<sup>70</sup> Cf. EHMIG 2007, 218.

<sup>71</sup> EHMIG 2003, 28. On the *amphorae* used to transport olive oil found in Cologne, see MARTIN-KILCHER 1994a, 385ff. EHMIG 2007b, 218f.

A particularly striking instance of the strong economic ties between the German provinces and the *Baetica* is the civilian settlement of Waldgirmes, which dates to the early years of the Roman settlement of Germany.<sup>72</sup> Waldgirmes itself existed only for around 19 years at the most before it was abandoned again. This makes it all the more astonishing that, so far, we can account for no less than 393 Dressel-20 type and 110 Haltern-70 type *amphorae* within the archaeological record of Waldgirmes. All of these *amphorae* originated in the Guadalquivir valley—the heart of the *Baetica*.<sup>73</sup>

Transport by the route of the rivers Rhône, Saône and Moselle is considered as the primary means of traffic and the provisioning of both legionary camps and civilian settlements along the Rhine.<sup>74</sup> But was this inland route really more profitable than the Atlantic route? In fact, there existed no unbroken river route. In order to connect to Saône and Moselle rivers, goods had to be carted overland to an unspecified point of intake on the Moselle, of whose navigability in this regions during the Roman period we have no reliable information. Further evidence for river transport may be found in a number of limestone blocks found in Mainz and Lahnau-Waldgirmes that originated in a quarry near Norroy-lès-Pont-à-Mousson<sup>75</sup> as well as in a sarcophagus found in Bonn that was fashioned around AD 211-222 from a block of stone weighing multiple tons and also originating from the same quarry.<sup>76</sup> Blocks of stone were apparently transported down the Moselle river for a total distance of 325 km.<sup>77</sup>

A passage from Tacitus, though, serves as a reminder that the missing connection between Moselle and Saône was a considerable obstacle. In this passage, he refers to efforts in constructing a canal between the two rivers.<sup>78</sup> The undertaking was ultimately to fail on account of the petty jealousy and opposition of Aelius Gracilis, the governor of the province of *Belgica*. Had it been completed, the Rhône-Saône-Canal would have considerably eased transport over the major waterways of the Gallic and German provinces and have reduced costs drastically. There were no insurmountable technical difficulties in the project; watergates and sluices were already well known to the Romans.<sup>79</sup> From a topographical point of view, it would also have been possible to overcome the European Watershed north of Remiremont, as the efflux from the Moselle would have been sufficient in this sector, both for shipping and for a canal.<sup>80</sup> The Moselle river was thus navigable at least as far as Épinal or Remiremont.

What about the Saône? Brian Campbell, in his study on “Rivers and the Power of Ancient Rome”, asserts that Chalon was the terminus for river transport on the Saône and the reloading station for “the overland journey to the head of the Moselle valley”<sup>81</sup>, without providing extensive

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<sup>72</sup> BECKER 2015, 232ff.

<sup>73</sup> Armin Becker was kind enough to provide me with up-to-date numbers (February of 2015); the excavations in Waldgirmes are supervised by Ulrike Ehmig. Excavations in Haltern show a strikingly similar picture; cf. RUDNICK 2012, 276ff.

<sup>74</sup> ROUGÉ 1996, 93ff.

<sup>75</sup> STRIBRNY 1987, 6ff. u. 98ff. BRACHERT – KELLER 2003, 172ff., bes. 175.

<sup>76</sup> This sarcophagus was re-used later (during the second half of the 3<sup>rd</sup> century) in Weilerswist-Klein. Cf. HARTKOPF-FRÖDER – BRACHERT 2004, 59 and 61ff.

<sup>77</sup> ZIMMER 2014, 22, has calculated the total length of the route to Waldgirmes at 462 km, of which 325 km were covered on the Moselle, 7 km on the Rhine and 130 on the river Lahn. BESNIER 1933, 358f. contends that the Moselle was navigable at least from the confluence of the Meurthe onwards.

<sup>78</sup> Tac. *ann.* 13,53.

<sup>79</sup> Plin. *NH* 3,53 asserts that the Tiber river, as well as its tributaries, the Tinea and Clanis, were only made navigable by pooling its waters in collecting basins (*piscinae*) before allowing it to flow freely. Cf. BOCKIUS 2007, 91f.

<sup>80</sup> Ibid. 87f. ZIMMER 2014, 23.

<sup>81</sup> CAMPBELL 2012, 271. He further mentions Metz (*Divodurum*) and Trier (*Augusta Treverorum*) as important wayposts on the Moselle.

supporting evidence for this.<sup>82</sup> The academic consensus views the overland route as leading through the Plateau-de-Langres, which would have meant a minimum distance of ca. 240 km to the nearest possible destination, Épinal.<sup>83</sup> By contrast, the main road from Langres to Metz encounters the Moselle at a point 6 km upriver from Pont-à-Mousson, near Scarponna (Dieulouard) and the river would have been navigable from that point onwards. The land road from Langres to Pont-à-Mousson would have travelled a distance of more than 270 km, while the one from Langres to Metz would have covered more than 300 km.<sup>84</sup> Travelling further north on the Saône river would have shortened the land route considerably, and, indeed, river vessels were found in Montseugny, Apremont, Gray and Rigny, though an exact dating of these finds has proven all but impossible.<sup>85</sup>

Of great significance is the discovery of a logboat in 1877 near the commune of Scey-sur-Saône-et-Saint-Albin. Carbon dating has shown it to have been built in the 13<sup>th</sup> century.<sup>86</sup> This is conclusive evidence for the navigability, at least for smaller ships, of the Saône as far north as Scey-sur-Saône (river mile / *Stromkilometer* 356), possibly even Corre (*Stromkilometer* 407).<sup>87</sup> Interestingly, the medieval logboat bears a remarkable resemblance to Roman river barges of the Zwammerdam-3 and Woerden-3 types.<sup>88</sup> The distance from Corre to Remiremont/Épinal was a mere 54/52 km overland. By contrast, from Scey-sur-Saône, cargoes would have had to travel a total of 69/77 km to Remiremont/Épinal.

Let us now look at the Atlantic route. While the consensus has long been that Roman seafarer by no means only travelled along the coast lines, there are still areas where our knowledge of Roman seafaring capabilities is unsatisfactory. In gauging Roman activity on the Atlantic, an important question remains concerning the efficiency and capabilities of Roman merchantmen. There are limits to our knowledge of how oceangoing vessels reacted to the winds and currents of the Atlantic (and the Mediterranean) and thus to our potential to gauge the efficiency and limits of the Atlantic route. The only way of ascertaining the capabilities of ancient ships with any degree of certainty is by reconstructing and testing them, using high-tech digital measuring tools. Simple test runs using GPS systems are not sufficient, as ship-displacement by winds and currents have to be filtered out of test results. A suite of measuring instruments and software has been developed in the last decade and while, sadly, no full-scale replica of an ancient merchantmen (yet) exists, reconstructions of three Roman military craft from the imperial period provide us with at least approximate results, using the Silva Marine NX2-system, an ensemble of measuring tools originally developed for the America's Cup and adapted to scientific use by a team of astrophysicists from the University of Hamburg and the Harvard-Smithsonian Center of Astrophysics.<sup>89</sup>

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<sup>82</sup> See, also without evidence, KING 1990, 115.

<sup>83</sup> Remiremont as a destination would have added 5 km to the overland journey and further extended the subsequent transport via the Moselle by 27 km. For land transport from Chalon-sur-Saône by way of the Plateau-de-Langres, see KRIER 1981, 34f. Cf. also GOUDINEAU – FÉVRIER – FIXOT 1980, 98f.

<sup>84</sup> On the direct route between Langres and Metz, see WIERSCHOWSKI 1995, 149. In the case of the wine trade by the *utriclarii*, KNEISSL 1981, 184ff. prefers the trajectory via Langres, Toul and Metz to Trier, and thence onward to Cologne. Two other land routes starting from Chalon-sur-Saône, one going west to Paris-Rouen-Le Havre or Amien-Boulogne respectively, the other heading east to Besançon and on to the upper Rhine, are also possible.

<sup>85</sup> BONNAMOUR 1998, 14f. BONNAMOUR 2000, 55 u. 63.

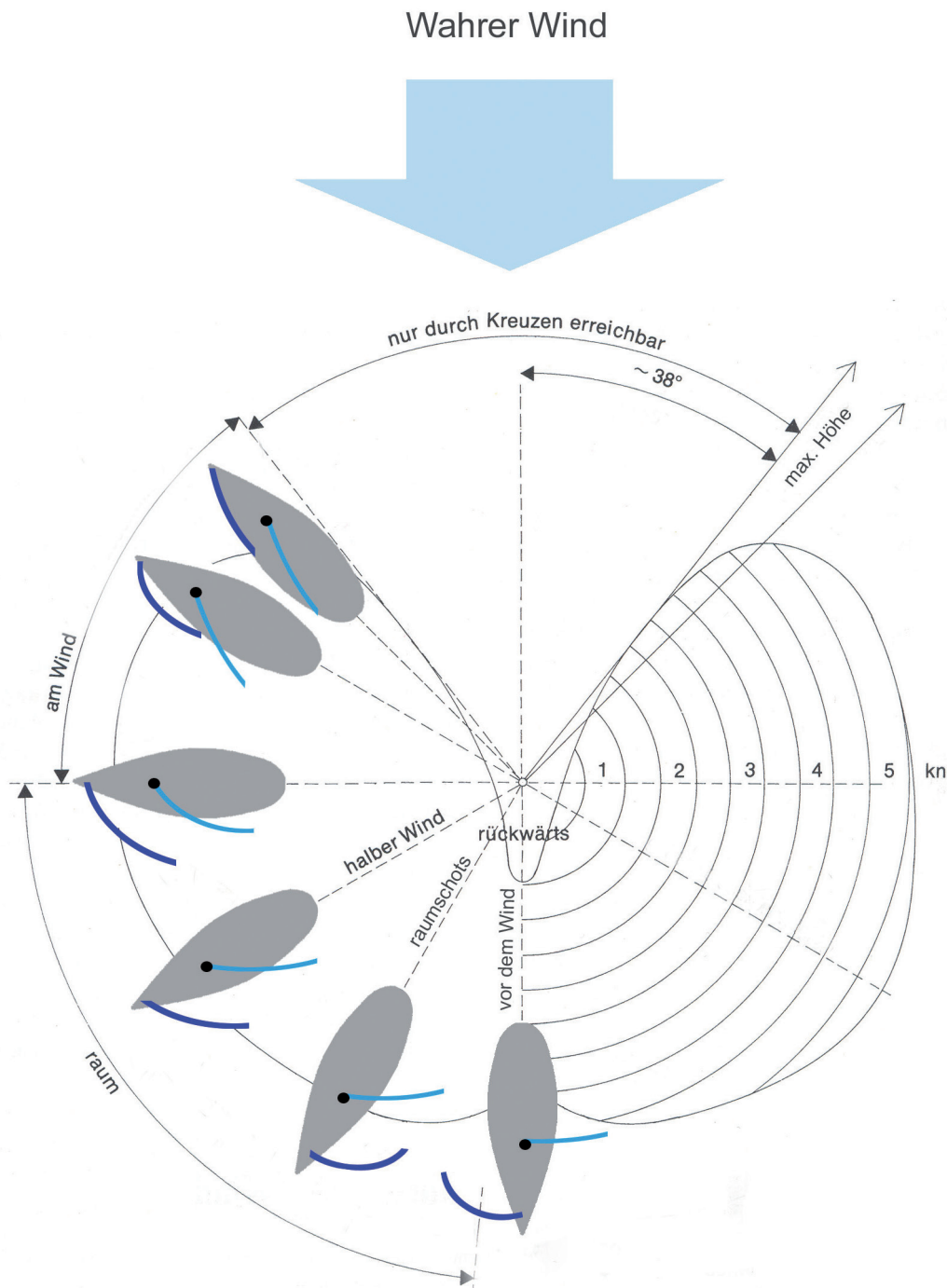
<sup>86</sup> RIETH 1994, 152ff.

<sup>87</sup> For an introduction to river mileage on the Saône, see the *Guide de navigation fluviale. Les voies navigables de la Saône*, 11 u. 21. EDWARDS-MAY 2011, 304.

<sup>88</sup> DE WEERD 1988, 69ff. u. 304ff. DE WEERD 1977, 190. DE WEERD 1978, 16ff. DE WEERD 1987, 389ff. BOCKIUS 2002, 50ff.

<sup>89</sup> SCHÄFER 2008, 70ff. SCHÄFER – WAGENER 2008, 99ff. GÜNTHER – WAWRZYN 2008A, 118ff. GÜNTHER – WAWRZYN 2008b, 111ff.

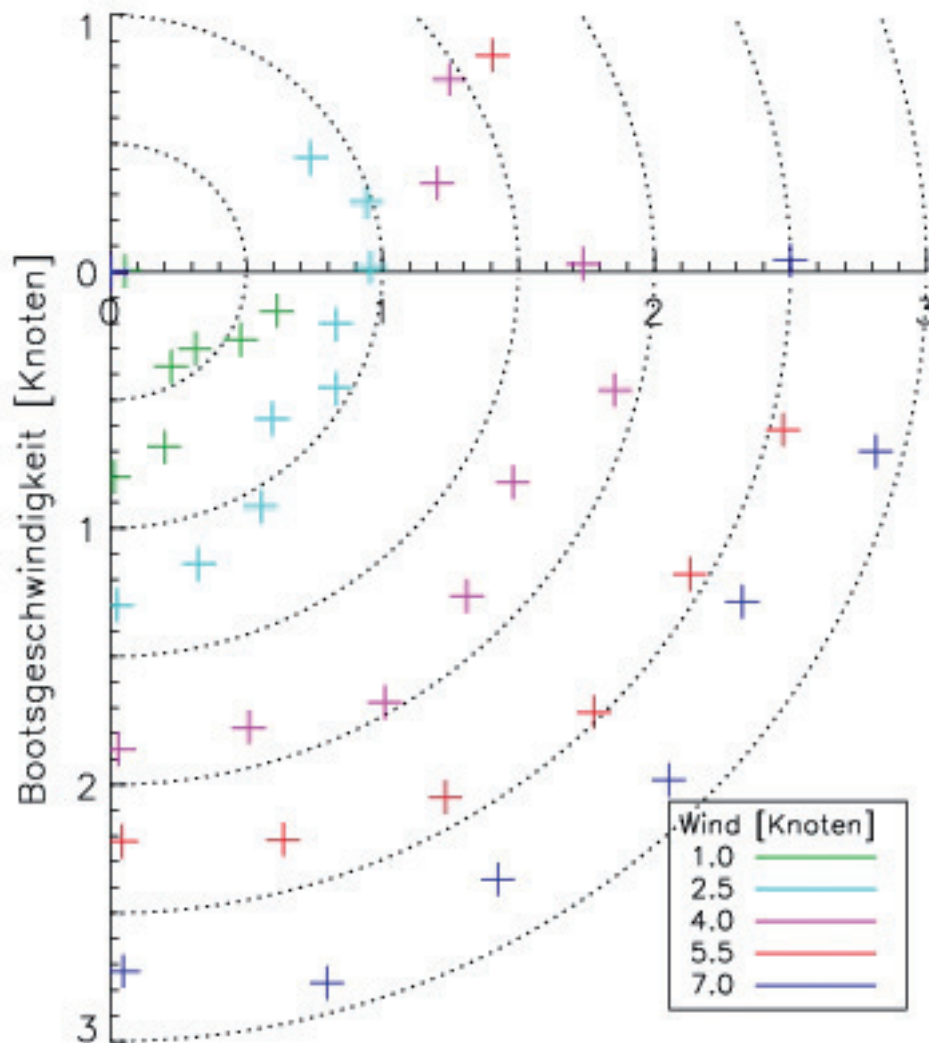
A ship's capabilities is usually shown by way of 'polar plots' (or simply 'polar'), a rudimentary graphical plot showing potential boat speeds across varying wind angles and wind speeds. It is used to indicate optimum sailing angles for any given ships. In the case of a modern sailing yacht, a polar typically takes the following shape:



**Fig. 1. Polar plot of a modern sailing yacht.**



For the reconstruction of a Roman military river craft of the Oberstimm-1 type, dated to around AD 100, a polar plot has also been calculated:



**Fig. 2. Polar plot of the reconstructed Oberstimm 1-type vessel.**

Trial runs with the reconstructed vessel have shown that ships carrying square sails (typical both for the ancient world and for medieval Europe) tend to perform admirably, not only when running before the wind or reaching (i.e. sailing in various fashions at an angle approximately perpendicular to wind direction), but also when sailing close hauled (i.e. close to the wind or even slightly upwind). This is remarkable, not least because we are dealing here with a type of vessel explicitly designed for oar-propulsion and for navigating rivers (not the open sea), which may hint at even better performance by oceangoing merchantmen, designed and optimised for sailing and for the open sea. But what effect do these test results have on the feasibility of the Atlantic route and our calculations of transportation costs?



**Fig. 3. Reconstructed Oberstimm 1-type vessel “Victoria” during trials on Lake of Ratzeburg.**

*Cornell's Ocean Atlas* indicates median wind speeds up approximately 4-5 Bft for the month of March, with a slight tendency for southwestern and western winds.<sup>90</sup> For the route *Baetica*-Rhine estuary via the Atlantic Ocean, southwestern and western winds pose no great problem, as test runs with the Oberstimm-1 type have shown that sailing a beam reaching course is perfectly possible for square-sailed Roman ships.<sup>91</sup> Meteorological conditions in the Bay of Biscay are generally favorable, in any case, as confirmed by data provided by the *Deutsches Hydrographisches Institut*, which records a maximum of 12% of wind speeds reaching 8 Bft or more, even in January. During July, the chance of such wind speeds rests at a mere 0,9%.<sup>92</sup> As a whole, then, the Bay of Biscay is easier and less dangerous to sail even than the Gulf of Lyon, which shows a likelihood of storms that is double that of the Biscay. In addition, the Gulf of Lyon is notorious for being storm-prone during the whole year, not least because of the strong Mistral winds blowing from a northwesterly and northerly direction.<sup>93</sup>

As a result, the Atlantic route would not have been noticeably longer than the Rhône route; indeed, sometimes it will have been considerably shorter, depending on precisely what overland route was chosen. In general then, transport distances across the Atlantic ocean were not drastically longer than those across the Mediterranean and the inland waterways of Gaul and Germany. For example: for a shipment destined for Mogontiacum, one of the most important legionary bases on the Rhine, the Atlantic route would have stretched over 3010 km, while the different possible routes using the large river systems of Western Europe would have amounted to a total of either 2886, 3052 or 3059 km.

<sup>90</sup> CORNELL 2011, 13.

<sup>91</sup> As confirmed by WHITEWRIGHT 2011, 3ff., esp. 7.

<sup>92</sup> DEUTSCHES HYDROGRAPHISCHES INSTITUT 1969, 53ff. In the region of the inner bay (i.e. close to the coast), wind speeds in January reach a median strength of 3 Bft in January and 5 Bft in Juli. This means that an outer course would have been preferable during the summer months. Calculated across a whole year, wind speeds of 8 Bft occur only during 7% (outer Bay) and 5% (inner Bay) of the time. Thus, the probability of encountering storms is barely elevated on the open sea, as compared to the inner bay regions.

<sup>93</sup> DEUTSCHES HYDROGRAPHISCHES INSTITUT 1959, 86f. u. 91ff.

R. Duncan-Jones, after careful examination of the written evidence for merchant transport, has calculated a ratio of 1:4,9:28-56 when comparing the relative costs of transport by sea, river, and land.<sup>94</sup> If anything, this is a conservative estimate, though it has not remained without criticism. M. Polfer has doubted the high costs of overland transport and has preferred comparative data from 17<sup>th</sup> century England, provided by D.P.S. Peacock, thus arriving at a ratio of 1:4,7:22,6.<sup>95</sup> Recently, P. Warnking has convincingly argued that total time of travel, rather than distance or means of transport, has the most influence on transportation prices.<sup>96</sup> But if we are to utilise the ratio as laid down by Duncan-Jones for the moment, we arrive at the following picture.



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<sup>94</sup> DUNCAN-JONES 1982, 368.

<sup>95</sup> POLFER 1991, 288ff. PEACOCK 1978, 49.

<sup>96</sup> WARNKING 2015, esp. 145ff.





**Fig. 4 and 5. Sailing the Oberstimm 1-type vessel “Victoria”.**



*Atlantic route*

<i>Distance</i>	<i>Type</i>	<i>Factor</i>	<i>Cost-factor</i>
2480 km	Sea transport	1	2,480
530 km	River transport	4,9	2,597
		<b>Total</b>	<b>5,077</b>

*Rhône-Saône route (overland: Chalon-sur-Saône-Metz)*

<i>Distance</i>	<i>Type</i>	<i>Factor</i>	<i>Cost-factor</i>
1780 km	Sea transport	1	1,780
803 km	River transport	4,9	3,935
303 km	Overland transport	25/56	8,484/16,968
		<b>Total</b>	<b>14,199/22,683</b>

*Rhône-Saône route (overland: Scey-sur-Saône-Remiremont)*

<i>Distance</i>	<i>Type</i>	<i>Factor</i>	<i>Cost-factor</i>
1780 km	Sea transport	1	1,780
1203 km	River transport	4,9	5,895
69 km	Overland transport	25/56	1,932/3,864
		<b>Total</b>	<b>9,607/11,539</b>

Comparing these results, it becomes obvious that the Rhône-Saône route was more expensive by far than the Atlantic route, by a factor of between 2.8-4.47 or 1.9-2.3 respectively. This, it should be noted, is based exclusively on the transport distances, excluding the costs of transshipping and/or reloading as well as the potential costs of loss by spillage or theft.<sup>97</sup> These calculations furthermore, while striking, are not in themselves sufficient evidence for an analysis from a transport cost economical point of view. Here, we have to consider other aspects such as transport speeds, personnel costs, maintenance costs, etc. This naturally would go well beyond the scope of this present paper. A more detailed analysis will have to be undertaken elsewhere.<sup>98</sup>

One thing already appears certain, however: the importance of the Atlantic route can no longer be argued against and the argument of José Remesal-Rodríguez' is indeed strengthened considerably by our preliminary results. The complexity of the Roman oil trade and the transport logistics necessary in getting the oil to the Rhine region further reinforce the notion of a high-performance Roman economy and lend themselves ideally to further analysis by way, e.g., of transport costs economics.

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<sup>97</sup> TCHERNIA 2013, 532 is right in pointing out that the long distances travelled by merchant goods quickly transformed them from standard consumer goods into luxury items. Cf. also HARRIS 1993a, 27f.

<sup>98</sup> See Schäfer (forthcoming) for detailed calculations.

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## **THE EPNet PROJECT: A NON-CONVENTIONAL FRAMEWORK FOR FALSIFYING HISTORICAL THEORIES**

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### **1. MIXING AND NOT MIXING TEAMS: THAT IS THE QUESTION?**

Due to the frequent use of concept like “inter/multi/trans-disciplinary” in research projects, we can get often confused about the real meaning of the different terms. In the common understanding, multidisciplinary draws on knowledge from different disciplines but stays and impacts within their boundaries. Interdisciplinarity analyses, synthesises and harmonises links between disciplines into a coordinated and coherent whole. Transdisciplinarity transcends their traditional disciplinary boundaries with the expectation of an innovative and emergent approach...in other words, the resulting approach should be more than the sum of its parts.

The idea that transdisciplinary is a “generative” approach (i.e the interaction between the disciplines is more than the sum of them) has a long history. For example, Warren Weaver (famous American scholar involved in science policies in the United States), was forecasting in 1948 *that the great advances that science can and must achieve in the next fifty years will be largely contributed to by voluntary mixed teams, some what similar to the operations analysis groups of war days, their activities made effective by the use of large, flexible, and high-speed computing machines.*

More than fifty years have passed and mixed teams of scholars from different fields have become pretty common in several scientific fields, from genetics to neurosciences, from biology to environmental studies, generating entire new fields of research where computational aspects are now fundamental.

In this new science landscape, History remains one of the “pure” field, where “mixing” team is extremely rare and the use of computational models and simulations are exceptions.

The idea that the complexity of human history cannot be reduced and reproduced using a computer simulation is still the common assumption in the field of History. However, in the last decade several scholars have argued and counter-argued on such theme, and several “insilico” experiments for exploring past human and social behavior have been tested, showing how computer simulation provides a powerful virtual laboratory in which to experiment (Madella and Rondelli 2014). Nevertheless, in the wider community of History, the step towards the idea of a virtual laboratory is still perceived more as an act of faith or black magic than as a scientific tool. Why?

Our suggestion is that this should be referred to the fact that in History models and theories are built using an abductive reasoning: the type of reasoning where one seeks to explain relevant evidence by beginning with some commonly well known facts, that are already accepted and then working towards an explanation.

Historians tend to build theories starting from the analysis of the correlations and recurrences of patterns, instead of using those correlations for validating a pre-defined theory, then when a new correlation is discovered, a new theory is proposed. This explains the importance and the great effort in History research for data collection, gathering, management and analysis, from the creation of the first database to the currently trendy use of “big data in History” (Armitage and Guldi 2014). However, correlation doesn’t imply causation, and a more rigorous approach to falsify existing theories would definitely benefit the scientific debate within History. The mixed teams, we were mentioning before, should indeed work together for building experimental laboratories not only for collecting and analyzing correlations, but mainly for falsifying rigorously different hypotheses and theories. This should include:

1. Improving the semantic representation of the existing hypotheses and theories, making more explicit, consistent and transferable the reasoning (interpretation) behind them.
2. Applying quantitative approaches for testing and validating those theories, to be able to explore the probabilistic acceptability of them and to compare rigorously alternative options.

As a consequence of this approach, we will be able to encourage the re-interpretation of experimental data and the generation of novel hypotheses and theories, as well as of driving a more consistent and coherent data collection approach.

With this groundbreaking objective in mind, we started a very ambitious experiment, for creating a mixed team of historians, experts of semantic modeling and reasoning, experts of computer simulation and quantitative methods: we created the EPNet project.

## 2. THE EPNET CHALLENGES

As we introduced before, history is based on an abductive reasoning, and the evolution of the discipline strongly depends on the capacity of arguing, testing and falsifying previous theories.

The EPNet project (03/2014-02/2019) born exactly with this aim. The main goal of EPNet ([www.roman-ep.net](http://www.roman-ep.net)) is the use of computer simulation as a virtual laboratory to encourage the formalization and falsification of scientific hypotheses about political and economic mechanisms characterising the evolution of the Roman trade network.

To do that, we can identify the following objectives:

- Modelling the existing hypotheses about Roman Empire trade system and compare them with empirical data.
- Exploring the emergence and dynamical behaviors of the Roman Empire trade network.
- Using network theory and social network analysis for the study of archaeological and historical sources as well as the definition of methodological guidelines.
- Applying formal model and quantitative analysis to falsify historical paradigms about Roman Empire economic and political dynamics, and stimulate the emergence of new ones.

Over the last couple of centuries, several scholars have developed a variety of theories to explain the organization of the Roman Empire trade system. In this context, the study of food management still represents one of the main debates among the field specialists. However, due to the lack of suitable sources, these theories continue to be speculative and difficult to falsify especially due to the lack of a formal framework for the analysis of the available data.

For this reason, in the context of the project, we mixed a team of Roman historians, computer scientists expert of semantic technologies, as well as scientists of complexity (from physics to evolutionary studies).

The project is articulated through three main innovative aspects. None is “new” by itself, but the combination of them represents an unexplored aspect (transdisciplinary), determining the originality and also the risk of this research:

1. Exploring existing dataset using an exhaustive semantic approach.

Semantic approaches can account for discrete data in addition to qualitative influences, so as to answer broader questions about motives and patterns of behavior. In that perspective, a semantic model consists of a network of concepts and the relationships between those concepts. The concepts and relationships together are often known as ontology. Semantic models enable users to ask questions about the information in a natural way and help identifying patterns and trends in this information and discover relationships between disparate pieces of it. The extensive data provided by the CEIPAC database ([ceipac.ub.edu](http://ceipac.ub.edu)) is thereby connected and subsequently interpreted in a variety of levels that is generating new insight to the complexity of exchange relations in the Roman Empire by moving beyond the limitations of a simple relational database. We consider this aspect essential for the generation of new knowledge about the object of study.

2. Applying network theory to the analysis of existing data.

Complex networks have become a very active field of research in the last decade providing a common language, which tools can have a wide range of applications. A clear example of this is the application of complex networks in economy in general, and trade in particular. Examples of trade between companies or banks, and even between countries have been the subject of intense research in



the last years. In EPNet we extend this characterization of trade networks for current economic data to the ancient trade network of some of the most basic products of Mediterranean diet (wine and oil).

3. Using agent-based simulation to analyze the structures and dynamics of the Roman Empire trade network.

As previously said, computer simulation can be implemented as a tool to explore research hypotheses. Complex network analysis generates several ideas about the dynamics of the system, but we need additional techniques to understand complex social spatiotemporal patterns such as those involved in Roman trade. Agent-Based Modelling is a particular type of computer simulation specialized in exploring problems which entities are capable of executing decision-making processes. These entities, the agents, interact both with other entities and with the virtual world where they live (the environment). The different processes are executed in a sequential series of regular time steps in order to check the evolution of the model over time. This mechanism can produce a chain of events capable of modifying the system and enabling new behavioral patterns to emerge from a bottom-up perspective, portraying complex qualities (the system as a whole exhibits traits that were not defined in the individual parts). The modification and improvement of the simulation will produce data suitable to be compared with our empirical one, which will show us the most probable historical situation. Moreover, it will allow us to improve the understanding of the interaction between local and large-scale trade interactions.

Empirical data will serve as bases for validation and calibration of the models and simulations. In this perspective, as the written sources that explain the economic reality in antiquity are truly scarce and dispersed, it is necessary to explore new sources in order to revise the whole subject and the inherent paradigms. However, we also think research should today make an effort to explore innovative ways of analyzing the existing data, in parallel with the collection of new data. In this perspective, the existing database of CEIPAC of Roman amphorae and related epigraphy acts as a validating opportunity for the model.

Roman amphorae can be considered as the best archaeological marker of Roman Empire economic production and transactions. They are a unique indicator of social relationships and chronological dynamics, because of their distribution throughout the Empire, the precise information contained in their epigraphy (similar to modern trademarks and labels) and their diachronic persistence. Moreover, a great number of scholars have paid enormous attention to these artefacts so that we can rely today on the existence of an abundant literature including and describing a large amount of these artefacts. This literature together with the existing databases will provide the empirical data needed to validate our models.

We are confident that EPNet represents a groundbreaking project in two specific aspects:

*1. Historical goal:* The aim of the project is primarily to enhance our knowledge of ancient systems and dynamics. We want to falsify existing theories concerning the roman economy: understanding which products and in which periods were distributed through the different geographical regions, as well as the role that different political and economic agents could

have played for controlling the products and the trade networks. In particular, a key question concerns the role of the state in the construction and control of the economic trade networks.

*2. Methodological goal:* The characteristics of the project imply the development of a new methodology. This will create new links between disciplinary fields and a new way of approaching our object of study. In particular:

- To promote the use of formal semantic in historical studies.
- To use formal models and computer simulation in History studies

EPNet proposes a non-conventional approach to working with and analyzing an historical problem. To maximize our chances of success, we encompass as many techniques as possible even if this represents, as any other new path, a high-risk project. The best way to accomplish our goal is a research strategy that crosses many disciplinary boundaries to create an integrated approach and focuses on problems and objects similar to the ones we have. Notwithstanding the fact that projects that involve several different disciplines usually have problems to get their components to understand each other, we are convinced that we have developed an optimal balance, which will make it possible to work in a transdisciplinary way and to develop a common strategy that will suit everyone. In order to do that, flexibility and communication are fundamental aspects to incentive the motivation of all the scholars involved.

Next section presents preliminary results of the ongoing research, integrating different expertise and skills.

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## THE WEIRD, WIRED PAST. THE CHALLENGES OF APPLYING NETWORK SCIENCE TO ARCHAEOLOGY AND ANCIENT HISTORY

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### INTRODUCTION

Food webs, neurons in the brain, the Internet and the World Wide Web, have very little in common except for the fact that they all are systems composed by a large number of interconnected elements. Since the last decade of twentieth century, it has been suggested - and it is nowadays largely accepted - that, if one is interested in understanding anything with similar characteristics, it is appropriate to consider the possibility to model it as a *network*.

A network is a set of items, called *nodes* or *vertices*, whose pairwise relations are represented as connections between them, called *edges* or *links*.

The study of networks, in the form of mathematical graph theory, has developed - since the eighteenth century, but mostly during the last century - into a substantial body of knowledge. At the same time, already in the 1930s, sociologists realized the importance of the patterns of connection between people to the understanding of the functioning of human society. [\[cit 1\]](#)

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<sup>1</sup> El presente trabajo se inserta dentro de los siguientes proyectos: Centro para el Estudio de la Interdependencia Provincial en la Antigüedad Clásica (CEIPAC) (2014 SGR 218) y HAR2015-66771-P (MINECO/FEDER, UE)

<sup>2</sup> Francesca Fulminante is grateful to the European Community support to her career and research through the FP7-IEF 628818, Marie Skłodowska Curie Actions Past-People-Nets.



Recent years, however, have witnessed a substantial new movement in network research, with the focus shifting away from the analysis of the properties of individual vertices or edges within small systems to consideration of the statistical properties of networks [[cit 2](#), [cit 3](#), [cit 4](#), [cit 5](#), [cit 6](#)].

In this new phase, the communities of physics, computer science, and applied mathematics have taken the role of the principal actors. Since the beginning, these researchers - to whom we will refer as network scientists - have exploited the possibility to study plenty of large databases, directing their efforts to the identification and characterization of universal classes into which, in principle, any real networks can be assigned.

As a consequence, the fields of application of the new analytical techniques have increased enormously and currently include biology, ecology, chemistry, neuroscience, logistics, among others.

Nowadays, it is a common knowledge that, regardless of the specificities of their research domains, scholars from different disciplines can find in this approach a valuable ally when tackling complexity.

If ecologists want to know how critical the survival of some species is for the stability of a given ecosystem with intricate trophic relationships, network science can be helpful [[cit 7](#)]. If physicians need to identify genes playing a major role in determining the clinical outcome of a disease, they can find network based techniques that have been designed for this aim [[cit 8](#), [cit 9](#)]. If public health agencies would like to know to whom they should recommend vaccination in order to prevent some virus from spreading, there are plenty of network models to suggest them how to select people for immunization [[cit 10](#)].

Ideally, network science advances through the combination of two complementary research approaches. The first one corresponds to when network scientists, looking at networks as abstract mathematical objects, identify a general question or problem and develop a method for addressing it. The second one is what researchers from any other field do when, trying to extract information from some data, find that the limitations of other existing methodologies prevent them from reaching their goal and come to the conclusion that adopting a network science approach may be the solution. In the first case, a “universal toolbox” (or theory) grows by abstracting from individual case-studies. In the second one, the understanding of a particular case-study (application) advances by applying the appropriate universal tool.

The main reason this linear way to progress is not realistic is a semantic issue. It is not a trivial task to translate into the specific language of each discipline questions that are expressed in terms as general and abstract as those normally used in network science. Moreover, if the choice of the appropriate technique is a difficult matter, determining the reliability of the output and interpreting it is even more complicated.

Additionally, such techniques have been developed for the analysis of available real networks, that is, publicly accessible digital data whose features have inspired the questions that network scientists considered worth to be addressed. Therefore, if the new set of data that one wants to analyse is too different from those studied till that moment, the appropriated technique may not have been invented yet. For instance, in some cases nodes are entities located in a geographical space (spatial networks [[cit 11](#)]). In some other cases, nodes represent objects that belong to different classes (e.g. affiliation networks [[cit 12](#)]) and can only connect with elements of the other class

(bipartite networks). For this kind of situations, tools developed to deal with data that do not have the same properties may lead to erroneous results. Sometimes, it is up to the researchers working on a particular case-study to adapt the existing techniques to the particular features of their data. However, they may prefer to design a way to pre-process the data in order to make existing analytic tools suitable for them. Some other times, network scientists may work on newly available data with novel properties, elaborate the questions and then create new tools. In many cases, both things happen at the same time and we have redundancy of questions and techniques expressed in different terms.

Another relevant aspect is that data do not come in network shape by themselves. It may happen that there is only one way to map them into vertices and edges, but this is not always the case. Consider, for instance, any of the online social networks. The most obvious approach is probably to consider users as nodes and friendships or following relationships as links. Although, it makes equally sense to take into account the interactions (like/favorite, share/reblog, messages etc.). In principle, depending on what the question is, researchers would choose the most appropriate network representation. However, if those carrying out the study are network scientists, they may not know enough about the details of the information embedded (or discarded) in the data and how it is connected to the possible research questions. On the other hand, if they are the experts who collected the data, but do not know much about the technicalities of network science, their choice may be influenced by the need to “keep it simple”.

At a more general level, it is worth noticing that it is not always immediately clear if a network approach can be useful in any way. In some cases, it is self-evident because interactions constitute the very basis of the phenomenon under study (contagion processes, trophic relationships, cascading failure...). However, in some other scenarios, the relational aspect of the data is just a secondary feature that can be included as a refinement and adopting a network perspective may or may not represent an improvement compared to previously existing methods. There exist multiple ways to process and extract knowledge or insights from data in various forms and most of them are older than modern network science. It is important to know the possible alternatives and to compare the results obtained through different methods. As a paradigmatic example, we can consider the task of grouping a set of objects. Such task can be performed through cluster analysis [cit 13, cit 14], collecting all the relevant information that define the objects and then measuring their similarity in order to classify them. The main idea is that those belonging to the same group (or *cluster*) are more similar to each other than to those in other clusters. But if such objects are nodes of a system mapped onto a network, we can also apply community detection algorithms [cit 15] to perform the same task. Community structure, i.e. the organization of vertices in clusters, with many edges joining vertices of the same cluster and comparatively few edges joining vertices of different clusters, is one of the most relevant features of graphs representing real systems. Cluster analysis relies on the characterization of individual objects, while looking for communities within a network implies that the focus shifts to their relations. Sometimes the results obtained with the two approaches are similar, some other times they are not. In any case, their interpretation is not the same. In order to choose the most appropriate approach, assessing the reliability of their outputs in abstract, statistical terms is crucial. Nevertheless, it is important not to forget the ideas underlying each approach, and their different algorithms, and how suitable they are for addressing a specific research question. Performing such evaluation requires expertise from different fields that cannot be easily found in a single researcher or research team. Obviously, this is just an example, but similar situations are ubiquitous when it comes to applying network science, or any other quantitative method, to a new class of case-studies.

Quite obviously, in order to avoid most of the shortcomings mentioned above, interdisciplinary collaboration is the way to go, even if a slow one. Researches carried out within collaborations between network scientists and experts of the case-study provide, arguably, the most interesting and reliable results. Unfortunately, the initial phase of mutual learning can get unfairly time demanding, especially the first time two disciplines try to communicate, when a common language needs to be established. The complexity of the task increases somehow proportionally to the distance between the discrete, often binary, quantitative language of network science and the language in which raw information is expressed.

Humanities are usually the hardest and History and Archaeology are no exception. Among the networks used as benchmarks for testing new techniques, there are networks constructed from data of airports and flights, of web pages connected by hyperlinks, of physical contacts between proteins, of functional parts in the cortical brain of the cat or other mammals; data about social grooming behaviour among primates, about the world trade web, about who hangs out with whom and many more. None of them have been published in history or archaeology journals, not even the one whose nodes are Florentine families of the XV Century [cit 16] which was built by political scientists meddling with history. Networks about Ancient History or Prehistory are nowhere to be found in papers and conferences (co-)authored by members of the network science's community.

However, this does not mean they do not exist. On the contrary, the number of papers on network applications to archaeological case-studies appeared on archaeology journals has been increasing continuously during the last decade [cit 17].

Formal network methods have been applied to explore research topics as diverse as the transmission of ideas [cit 18], the movement of people and objects [cit 19, cit 20], the identification of social and cultural boundaries [cit 21], interregional interaction [cit 22], and maritime connectivity [cit 23]. Besides the increasing number of journal articles, in the last four or five years, books and special issues have also started to come out, collecting contributions from tens of authors [cit 24, cit 25, cit 26, cit 27].

Nevertheless, there are several reasons why these works occupy an extremely peripheral position within the ecosystem of network science. Some of them can be regarded as “non-scientific” factors. For instance, the fact that a large majority of these papers were published quite recently, when the big hunt for benchmarks was already over. Moreover, it is not a common practice among researchers in humanities to publish datasets along with the results in their article and therefore such networks have very few chances to circulate. Other factors are instead entirely inherent to the peculiar nature of archaeological networks and their construction.

The resistance offered by raw historical or archaeological data is so difficult to overcome that it is almost impossible for network scientists to build networks by their own. To build a network from the archaeological record is challenging because, in general, one has to face all the typical issues of the other classes of data at once.

The main difference is that, normally, natural sciences and, to a less extent, social sciences collect the data they need by carrying out appropriate experiments, while this is not the case for historians and archaeologists. Even though occasionally scientists have no other option but relying

on observation alone, it goes without saying that it is when one is investigating past processes that the exception becomes the rule. Therefore, difficulties that researchers from other fields have to face more or less sporadically, archeologists and historians have to deal with them all the time.

#### NETWORK INFERENCE AND THE STUDY OF HUMAN PAST

In order to outline the most common difficulties, let us summarize here the basic ingredients for a proper network representation of a system:

1. A definition of such system that allows to identify its boundaries, separating what is within from what is outside.
2. A definition of the elemental parts that will constitute the nodes of the network
3. A definition of what the connections are supposed to mean and a well-defined way to determine whether they exist or not, that is, a way to measure them, or, if not possible, to infer them.

Depending on the circumstances, each one of these three ingredients may present different challenges. Before entering into details on the data-related questions, we would like to briefly discuss some ambiguities in the concepts and definitions that may be problematic even when the best possible data are available.

#### A MATTER OF BORDERS

The first ingredient may seem trivial, but it is not. It is not so infrequent that the system under consideration is indeed a part of a larger one with blurred borders. Such borders can be conceptual, spatial, or temporal, being the last situation especially relevant for historical and archaeological case-studies. In order to clarify what conceptually blurred borders are, let us consider an example involving acknowledged “good data”. If we want to follow the rise and fall of a topic on Twitter, we can consider all the tweets containing a given hashtag. Alternatively, we can include those containing a counter-hashtag as well. And perhaps other related ones. If we are interested in the behavior of a specific age-class, then we will exclude all the users whose age is not in the required range. Is it the right choice? What are we doing with those whose age is unknown? Should we leave them out? If we exclude users that are not in the category of interest, what happens with the interaction between those that belong in our system and those who do not? The typical issue related to spatial borders concerns the interactions with what is outside such borders. In a network where nodes represent settlements and links some kind interaction between them - for instance, routes or commercial exchanges - the decision about where to draw the frontiers of the system can be crucial. Even if the system under study is a political entity with well defined geographical borders, it can nonetheless be unwise to cut out everything that does not belong to that entity. Imagine one is interested in knowing whether settlements that are known to be important from other evidences or sources are also the most central ones according to some network analysis measure. Disregarding everything that is outside the borders, will make the node representing an important city connecting two regions as peripheral as any small village close to a desertic area. In a network made up of many nodes, from thousands to millions, vertices at the border represent a very small fraction and this kind of issues are just unimportant nuisances. On the contrary, when dealing with small systems, issues related to spatial borders need to be carefully tackled. Finally, establishing limits at the temporal dimension also give rise to some challenging questions.



Nodes can be created and destroyed; sometimes one splits into two, sometimes two merge into one. Connections appear and disappear; links may increase or weaken their strength. When dealing with systems that evolve over time, the so-called longitudinal networks, it is difficult to capture meaningful information in a simplified manner. Imagine someone trying to take a picture of something that is moving. The photographer surely will choose a fast shutter speed. But the temporal resolution of archaeological data is limited. It is like being in a dark place, unable to see subject clearly. The challenge is how to find the best tradeoff between a blurred and a dark image, that is, to select the appropriate time window when trying to reconstruct an evolving network.

#### THE CHOICE OF THE BUILDING BLOCKS

The definition of the nodes may represent a real difficulty if there are more than two scales (local and global) involved and are not clearly separated. If there are buildings, blocks, neighbourhoods and cities, it is crucial to make a choice. But is also important to know what to do with small towns, rural areas, or the outer districts of large metropolis. The spatial resolution can be not homogeneous enough. Geolocalized data from mobile devices have precise coordinates associated to them, but in many situations it can be more interesting to aggregate them into larger geographical units.

In most archaeological applications, nodes are contexts or attributes of contexts, that is, any kind of archaeological evidence. Archaeological findings in some cases can be naturally grouped together depending on the context they belong to (tombs, houses, settlements, etc.), but that may also be scattered over areas where no other remains have been found. Is it better to discard such records or should we aggregate them according to some criterion? Spatial nodes are not the only ones facing these dilemmas. If we are considering amphoric types or ceramic compositional groups, how are we supposed to deal with geographic variations or imitations? Basically, it is the issue of discretizing a nearly continuous spectrum of differences. We have already explained how cluster analysis algorithms can be helpful to group or classify objects based on their individual properties. Alternatively, it is also possible to accept different hypotheses, defining for each of them a different set of nodes and, consequently, a different network. The properties shared by a majority of such networks are robust to the uncertainty in the node definition and hence can be regarded as reliable.

#### FROM INTERACTIONS AND SIMILARITIES TO CONNECTIONS

Connections present an even broader range of issues. Obviously, in order to determine if a link does or does not exist, we have to rely on the available data. However, data do not always have univocal interpretation since, in principle, what defines the meaning of connections is the research question. Some networks, as for instance infrastructure networks, have connections that represent material objects: streets, cables, railways. Some others have links whose existence is established through an operational definition, that is, through a process, something the nodes do: there is a link from specie A to specie B if members of A eat members of B; there is a link between author A and author B if they have co-authored at least one research paper; there is a link from user A to user B if A follows B, etc. In all these cases, little room is left for ambiguities and interpretations. Other kinds of networks, however, have connections that represent a more ontological relationship between nodes: friendship, commercial partnership, political affinity, among many others. The existence of such relationships has to be inferred from the information available which need to be filtered and interpreted. Suppose that we have collected all the emails that people working at some company sent to their colleagues during the past month. The links extracted from this dataset will not be the

same if one intends to build a friendship network or a network of work-related cooperation. Then we have biochemical networks, which belong to the second category in theory, but in practice they do not, simply because not all the relations are directly measurable, not even in natural sciences. Think for example of a protein-protein interaction network, whose links are clearly identified through an operational definition, that is, physical contacts established between two proteins as a result of biochemical events and/or electrostatic forces. In order to build a network it is necessary to integrate data from different experiments that provide indirect evidence of lasting physical contacts that are difficult to detect directly.

Whenever direct observation is out of reach, regardless whether the cause is the nature of the relations or technical issues, links need to be inferred.

Typically, when trying to reconstruct past networks from archaeological evidences and historical sources, we have to face both difficulties. Many of the research questions that can be addressed through a network science approach are such that connections have an operational definition. From migratory flows and colonization processes to trade dynamics and commercial routes, to the study of the diffusion of a technological innovation or a cultural trait, nodes are generally social groups associated to places and links are interactions defined by a specific process. Hence it should be easy to determine if a connection did or did not exist and, in principle, to estimate its strength. In practice, gathering clear evidence of a certain kind of interaction is not always feasible. One possible option is to rely on statistics in order to determine the probability associated to existence of each link [cit 28]. Alternatively, one can relax the restriction on the type of interaction, a choice that allows to combine together all the available evidences but that, at the same time, gives rise to other issues.

It leads to building generalized networks [cit 29] where the meaning of the links has a less precise definition.

Suppose we have some data about a set of settlements that coexisted in time when a given process of interest was taking place. By taking into account any class of remains within some chronology and, when available, historical sources, we can deduce how culturally similar they were at those times. However, links established from cultural affinity are not derived by an operational definition. It is more the opposite: they are similar to the ontological type of connection we have discussed above. Similarity, in its broadest sense, is not a measurable quantity. One can quantify it, obviously, but there are many ways to do so [cit 30] and the procedure contains an ineludible amount of arbitrariness. Beside these technical issues, it is worth noticing that the relation between the ongoing process of interest and the similarities observed needs to be demonstrated, or at least upheld by heuristic arguments. Hence, basically, while the amount of data increases, drawing conclusions from them becomes more complicate.

Real case-studies, however, often enough allow for a mixed approach, something that is midway between looking for a direct proof of interactions of a specific type and including any kind of evidence, thus obtaining a too general cultural similarity measure. In many cases it is possible to use a variety of evidences somehow related to the process under study, then trying to infer the connections by means of a combination of tailored similarity measure and statistical tests. In the next sections, we will further explore this scenario through few illustrative datasets.

When it comes to nodes (sites) and attributes (artifact typologies), it is easy to identify two opposite situations between which all the possible spectrum of real cases would lie, that is, two extreme scenarios corresponding to maximal and minimal diversity among sites, respectively. We may have that each of the considered nodes has completely different attributes, which means that they are not related in any way and therefore in our similarity network there is no link that can be drawn. We would have a set of isolated nodes. The opposite to this scenario is a situation where all the attributes are equally distributed among the sites, each one of them having the same proportion of artifact typologies. In this case, the similarity measure will be maximal - regardless the details of its definition - and each pair of nodes will be connected by a link. We would have a fully connected network.

None of these extreme situations is realistic or interesting. In real cases, we expect some groups of sites (clusters) to be more similar among each other than to any other node in the system. The similarity network would then have a community structure and we could analyse how its communities are organized both internally and among each other. As a paradigmatic example, let us introduce a sample data from Huntley's [cit 31,cit 32] study consisting of counts of five ceramic compositional groups from nine sites in the Zuni region.

		CERAMIC COMPOSITIONAL GROUPS					Total
		DLH-1	DLH-2a	DLH-2b	DLH-2c	DLH-4	
S I T E S	Atsinna	16	9	3	0	1	29
	Cienega	13	3	2	0	0	18
	Mirabal	9	5	2	5	0	21
	PdMueitos	14	12	3	0	0	29
	Hesh	0	26	4	0	0	30
	LowPesc	1	26	4	0	0	31
	BoxS	0	11	3	13	0	27
	OjoBon	0	0	17	0	16	33
	Sp170	0	0	18	0	14	32
Total		53	92	56	18	31	

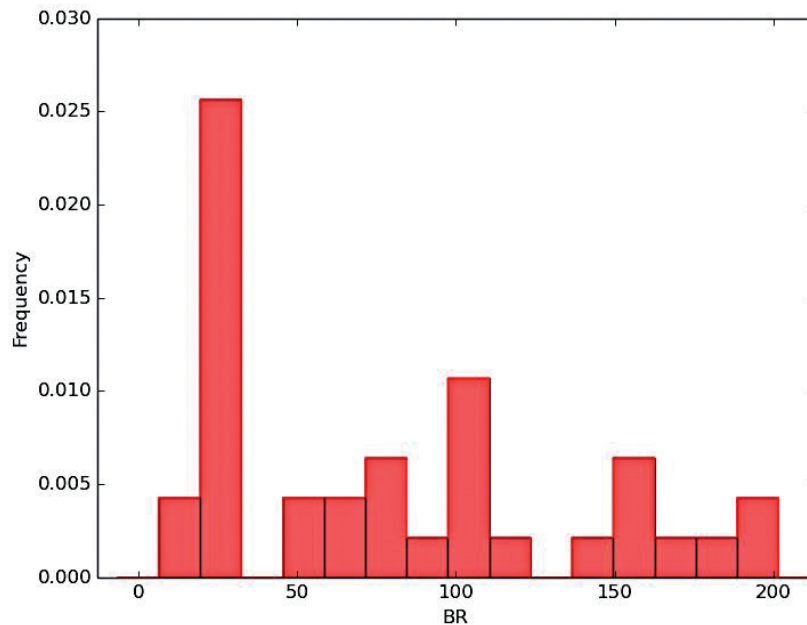
**Table 1. Sites and ceramic compositional groups of the Zuni dataset.**

We chose to measure the similarity between this sites by means of the Brainerd-Robinson (BR) coefficient because its definition is intuitive and it was developed within archeology specifically for comparing assemblages in terms of the proportions of types or other categorical data. BR is a city-block metric of similarity that is calculated as:

$$BR(i,j)=200-k=1pP_{ik}-P_{jk}$$

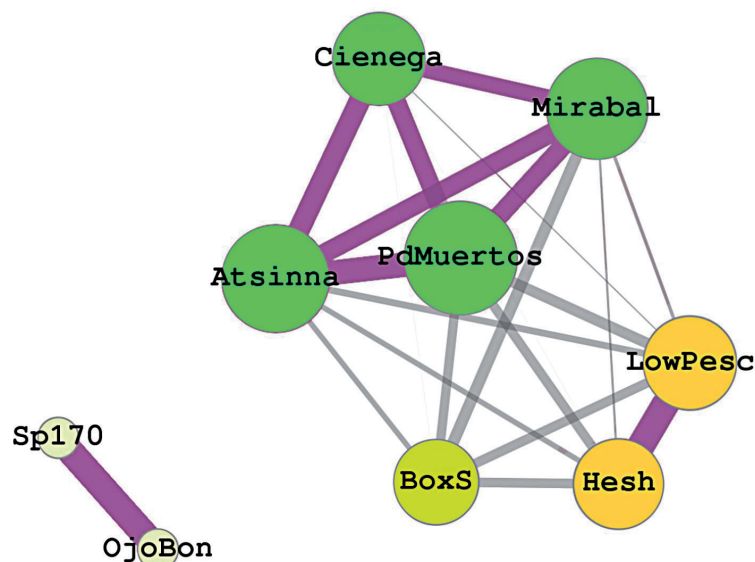
where, for all categories ( $k$ ),  $P$  is the total percentage in assemblages  $i$  and  $j$ . This provides a scale of similarity from 0-200 where 200 is perfect similarity and 0 is no similarity [cit 33] From a cursory inspection of the frequencies histogram of the BR values (Fig. 1), we can easily observe

that the pairs of sites naturally group into three classes: pairs having none or very little similarity ( $BR < 30$ ); pairs that are weakly similar ( $50 < BR < 120$ ); pairs whose similarity is stronger than average ( $BR > 130$ ).



**Figure 1. Frequency histogram of the BR values for the Zuni dataset.**

If we build the similarity network (Fig. 2) considering only the strong similarities (thick purple links), we will recover the three known clusters of settlements defined accordingly to their geographic location. Including the weak similarities, that is, adding weaker (thinner, grey) links to the network, we can see how two of them are related to each other and integrate the only site that does not belong to any cluster, while the third one is completely separated from the rest.



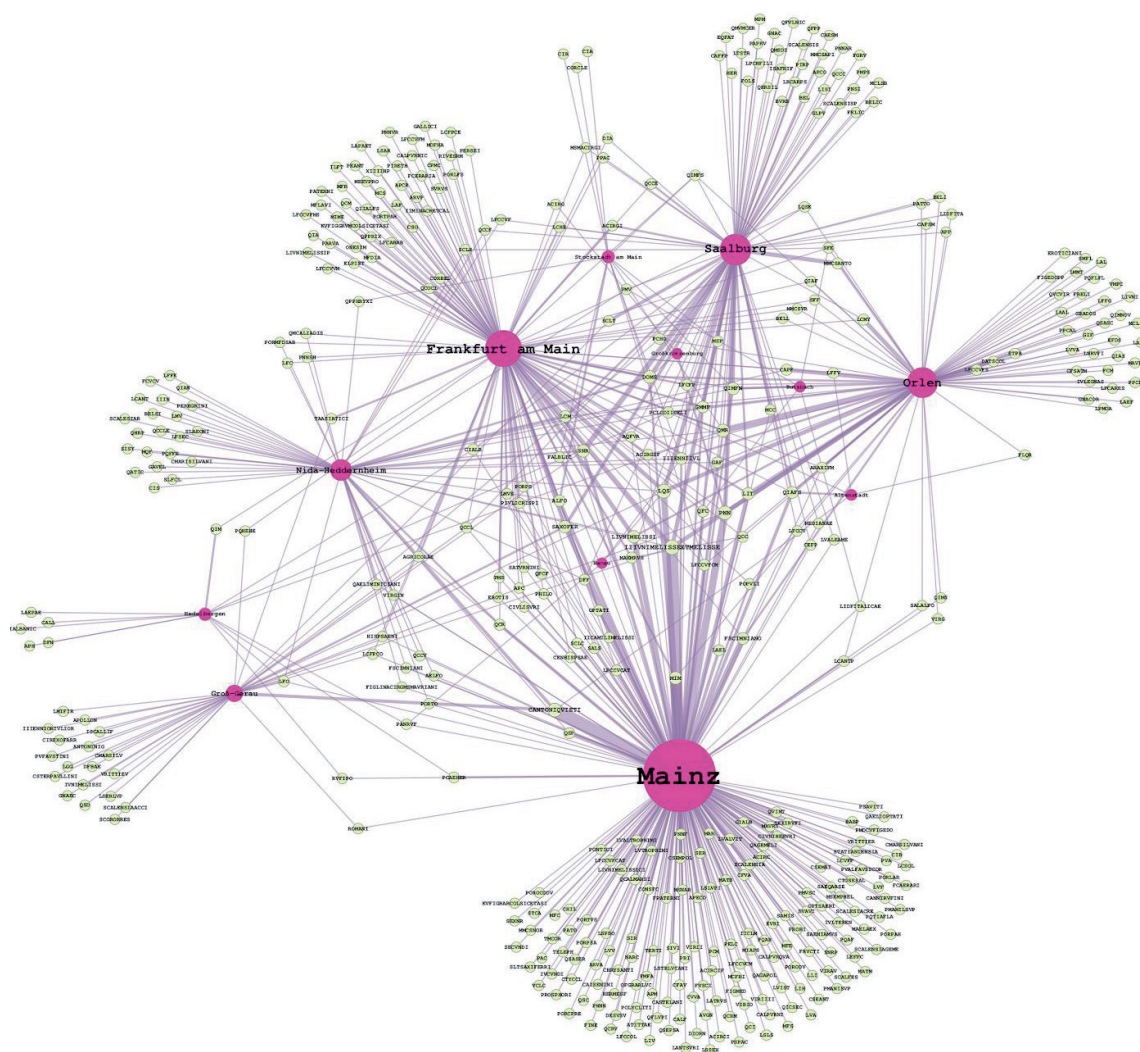
**Figure 2. Zuni dataset network of sites constructed according to the BR coefficient. Thicker links correspond to higher BR values; purple links correspond to BR values larger than 130. Node size is proportional to the size (number of artifacts) in the assemblage from the corresponding site.**



However, this simple example does not represent the most typical situation. Things are usually not this clean and self-evident. First of all, the appearance of three groups of BR values that can be interpreted as non-existent, weak and strong similarity is quite a rare fact. More commonly, BR values are continuously distributed in a more or less broad range of values. Moreover, in the Zuni dataset, both the five categorical attributes (compositional groups) and the nine nodes (assemblages) have a comparable number of samples, a feature that is not usual when dealing with archaeological data.

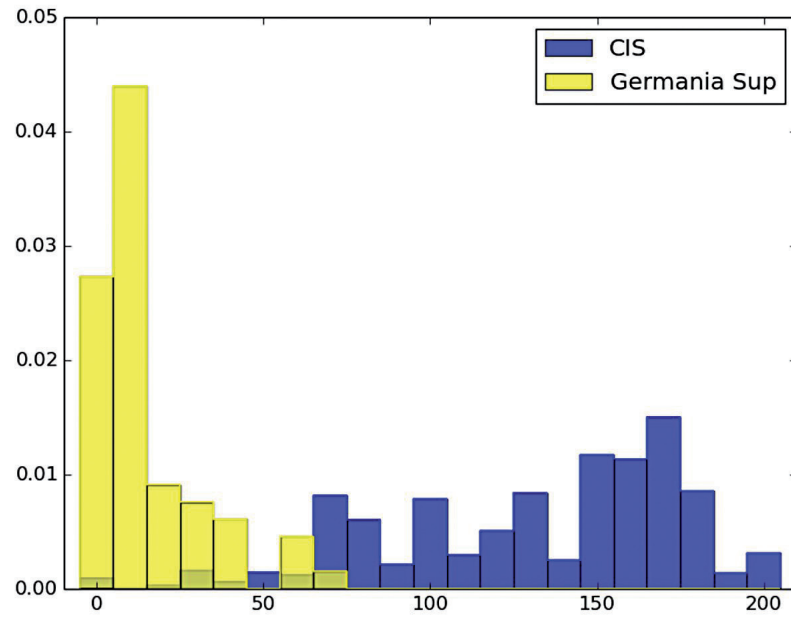
#### ASSEMBLAGES WITH HETEROGENEOUS SIZE: LOOKING FOR SIGNIFICANT SIMILARITIES.

Small assemblages are problematic because their composition is likely to be non-representative of the affiliations of the site. A reduced number of samples can be the results of a poor conservation or it may be the consequence of the actual small size of the excavated area. Sometimes, it can also indicate a real lack of the considered categorical attributes. Therefore, comparing their proportions may lead to wrong conclusions. We should be able, with the help of appropriate statistical techniques, to differentiate between the first two cases and the third one. Consider the ideal scenario of perfect uniformity among the sites. If the entirety of the assemblages is conserved, all the BR values will be equal to 200, but if only a fraction of them survived, then we would obtain smaller values as a consequence of sampling error. Suppose that this fraction of survived objects is small and that the size of the sites varies considerably. How can we discern whether what we observe are random differences within a group of highly damaged identical assemblages or instead represent something significant, inherent to the sites under study? Fortunately enough, the first case can be artificially reproduced by computer simulations. Actually, it is possible to reproduce such scenario thousands of times. Random samples of a specified size, based on the actual number of objects in each site, are drawn with replacement from a population with proportions defined by the actual total number of artifacts in each category. Then, we can compare the empirical data with the synthetic ones, determining the probability that what we observe from the archaeological evidence is “signal” and not “noise”, feature by feature. In particular, we will discuss the application of two statistical tests: one addressing the statistical significance of the similarity between pairs of nodes with given sizes; the other tackling the issue of the how significant the presence of certain category of data is in a certain node, given the relative abundance of objects belonging to that category and the size of the node. As a comparative example, we consider two datasets with opposite properties. The first one (from now on, DP), is not from an archaeological or historical case study. It is the result of a poll performed by the *Spanish Centro de Investigaciones Sociológicas* (CIS) about the political affiliation of the congresspersons in the Spanish Parliament after the general election of June 26th 2016. This time, the districts are the nodes, the political parties the categorical attributes, and the elected parliamentarians the objects or artifacts. The properties of this system are known, hence it can be efficiently used as a benchmark dataset. The second set of data (GS) we are going to analyse is from the EPNet project (ERC-2013-ADG340828). The nodes are settlements in the province of Germania Superior, while the categorical attributes are the different stamp-types found on olive oil amphorae, and each piece of amphora with a stamp is an object or artifact. The first dataset has much more nodes than categories and is quite close to the scenario of perfect uniformity, except for some districts that have their own political parties. The second one, on the contrary, is a case of extremely high diversity, with many categories, a large majority of them having just one or two representatives, and few nodes. In Fig. 3 it is shown the network representation of the associations between nodes (sites, in purple) and categorical attributes (stamp-types, in light green) present in the GS dataset.

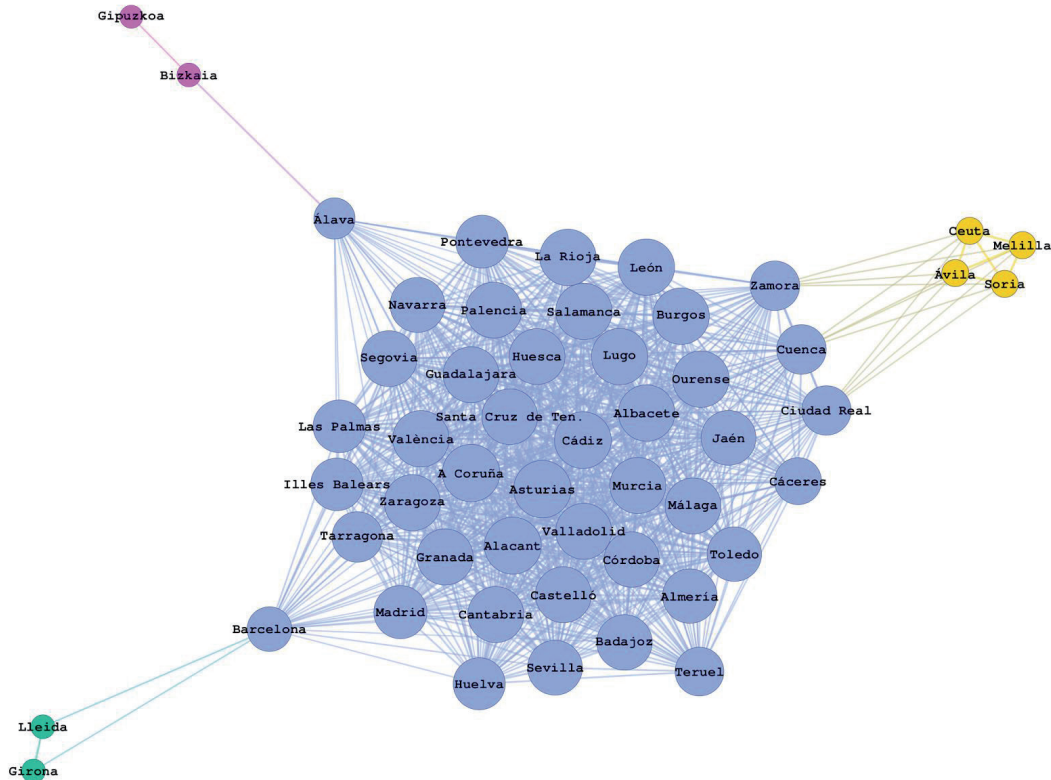


**Figure 3. GS networks of places (sites) and stamp-types (categorical attributes). Each node representing a place (in purple) is connected to stamp-types (light green) that have been found in its assemblage and its size is proportional to the total number of elements (stamps) in it. The size of nodes representing stamp-types is proportional to the number of stamps in that category. The thickness of the links is proportional to the number of stamps of a given stamp-type that have been found in a certain place.**

The differences between the two datasets can be illustrated effectively enough through the frequency histogram of the respective BR values (see Fig. 4).

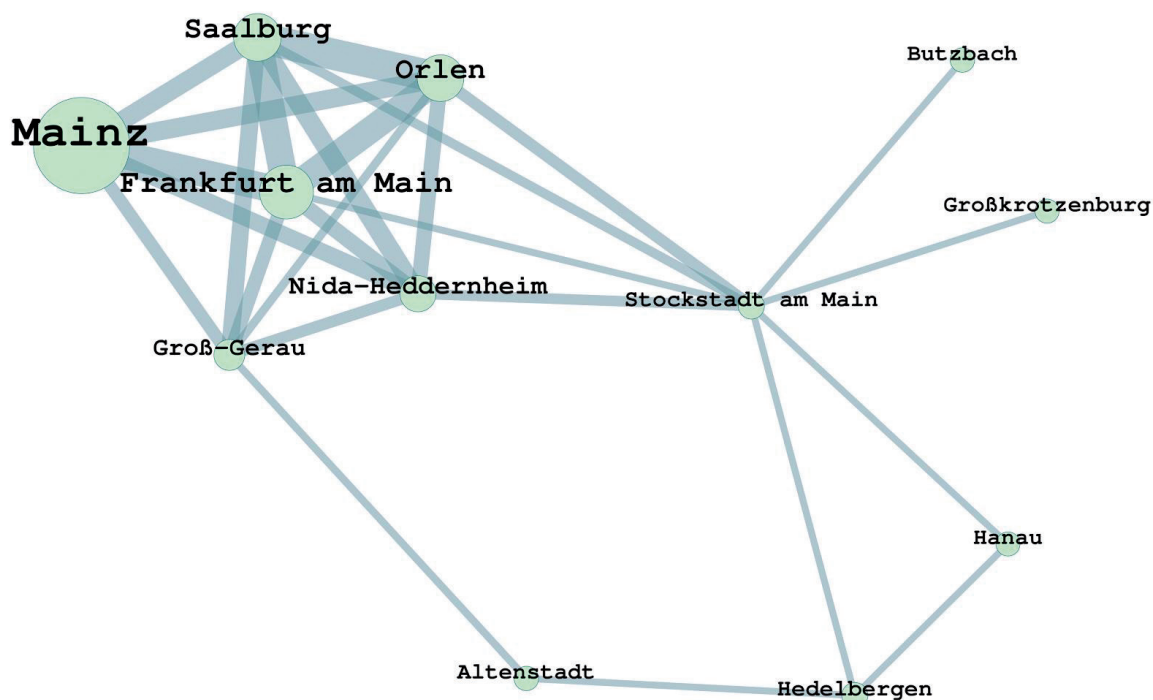


**Figure 4.** Frequency histogram of the BR values for the GS (in yellow) and DP (in blue) datasets.



**Figure 5.** DP network of districts constructed according to the BR values. Node pairs whose BR coefficient is greater than 115 are connected and the thickness of the link is proportional to their similarity value.

In neither of these datasets it is clear where one should put the threshold in order to separate BR values that have to be interpreted as links and values that do not represent relevant relationships. Obviously, the threshold value cannot be the same in the two cases. If we set it in such way that each site has at least one link, we obtain the networks displayed in Fig. 5 and Fig. 6, respectively, for the Spanish districts and the archaeological sites in Germania Superior. The threshold value has been set at BR=115 for DP and BR=14 for GS.



**Figure 6. GS network of places constructed according to the BR values. Node pairs whose BR coefficient is greater than 14 are connected and the thickness of the link is proportional to their similarity value. Node size is proportional to the number of stamps that have been found in the corresponding site.**

The statistical test concerning the significance of the similarities answers the question about how confident we can be that the measured BR values would have not been observed in random samples. A certain degree of similarity can be due to fact that, mixing the attributes randomly, some samples happen to be more alike, just by mere chance. This is especially likely to occur if there is a limited number of categories compared with the samples' size. Hence, the idea is that only the BR values that are very unlikely to be observed in randomized samples can be regarded as significant. Therefore, the correct criterion for adding links is not that of connecting pairs of sites whose similarity is above a given threshold value. A more appropriate criterion would be to add links between pairs whose similarity has a very small probability to be observed. This approach allows to take into account spurious size effects that would be neglected otherwise. Consider the case of Groß-Gerau, in the GS dataset. Its similarity with Saalburg is the highest one, being  $BR(\text{Groß-Gerau}, \text{Saalburg})=35$ , while it is quite less alike to Altenstadt ( $BR=16$ ). Nevertheless, Saalburg with its 121 stamps is a quite large site, while Altenstadt has only 6 stamps. It is not infrequent to obtain a similarity larger than that between Groß-Gerau and Saalburg in random samples of the respective sizes. On the contrary, this is not the case for a BR value equal to 16 for a sample of the size of Groß-Gerau (34 stamps) and another one as small as Altenstadt, as clearly shown in Fig. 7.



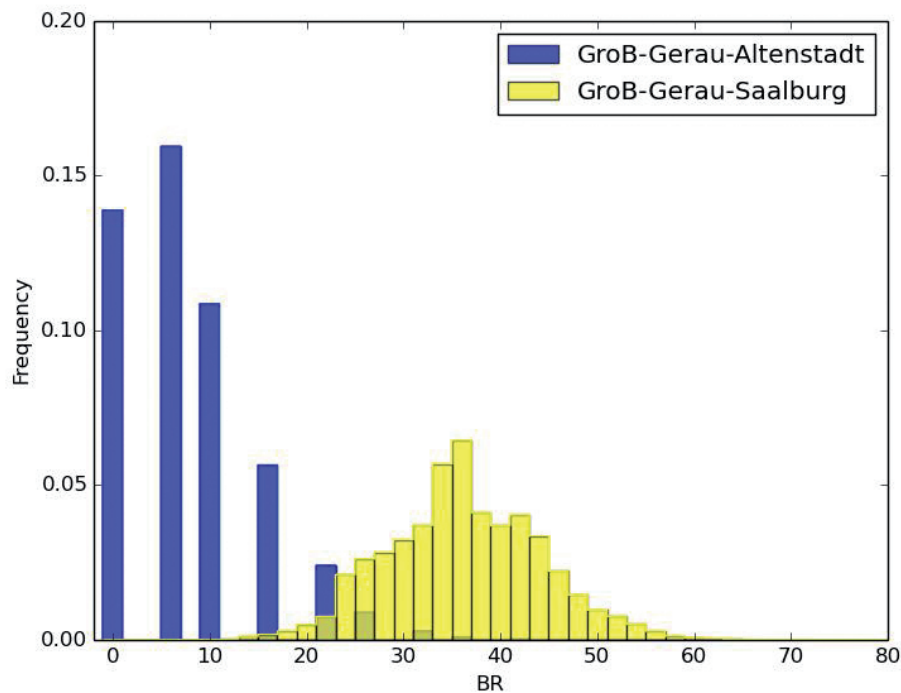


Figure 7. Frequency histogram of the BR values between randomized versions of two pair of assemblages: those of Groß-Gerau (34 stamps) and Altenstadt (6 stamps), in blue, and those of Groß-Gerau and Saalburg (134 stamps), in yellow.

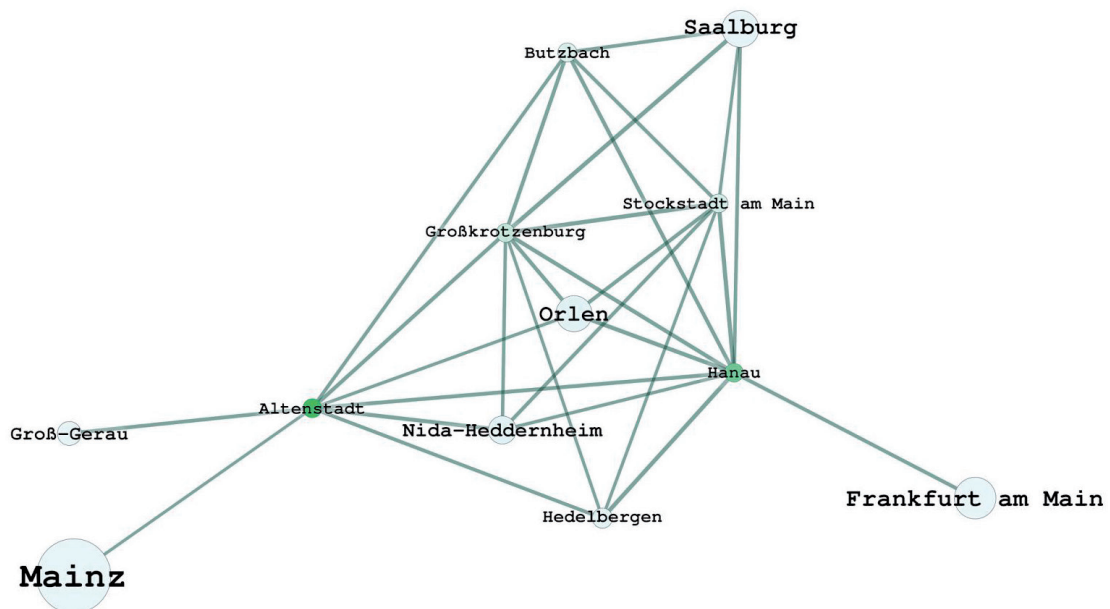


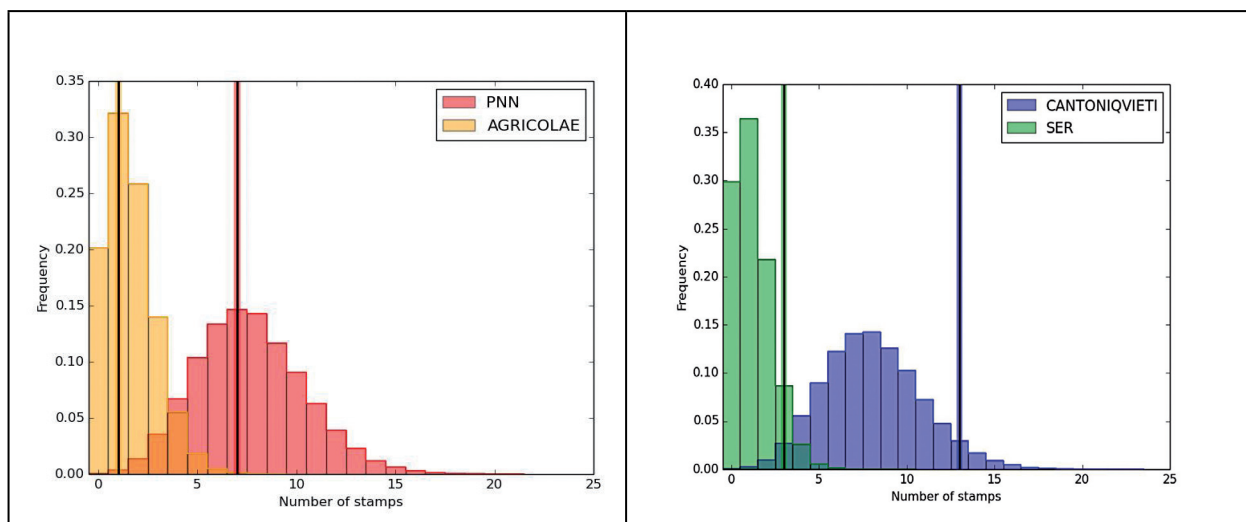
Figure 8. GS network of places constructed according to the probability that the BR value measured for a pair of nodes is larger than that of the randomized version of their assemblages. Nodes highlighted in darker green are those preventing it from becoming disconnected

Consequently, in a network constructed according to this new method, we will have a link between Groß-Gerau and Altenstadt, but no connection between the Groß-Gerau and Saalburg. In Fig. 8 we represent the similarity network of the sites in the GS dataset as inferred applying the approach we have just exposed, setting the threshold at a value such that each site has at least one link. In such network, the similarity between two connected nodes is higher than what we measured in two thirds of the corresponding randomized samples.

The size of the node is proportional to the total number of stamps found in the site. Comparing the pictures in Fig. 6 and Fig. 8, we can notice how all the largest nodes are no longer connected to each other. Beside, not all the small sites are in peripheral position. The nodes highlighted in darker green have 6 and 4 stamps, respectively, and are of fundamental importance for the system since they are preventing it from becoming disconnected. This is a further proof that assessing the possible role of chance does indeed allow us to correct a negative bias toward small assemblages, a bias that is implicit in the BR definition when measuring the similarity of samples with different size.

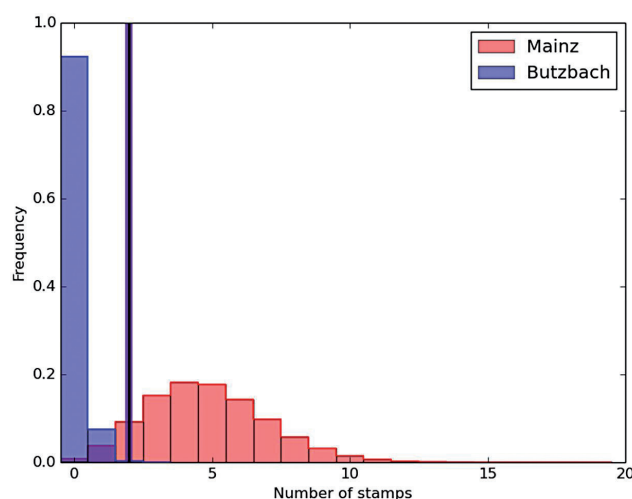
#### CATEGORIES WITH HETEROGENEOUS SIZE: LOOKING FOR LOCALLY OVERREPRESENTED ATTRIBUTES

Beside samples size effects, there are other issues whose impact deserves to be considered. Among them, the most relevant one is probably the heterogeneity in the size of the categorical attributes, that is, the variability in the number of objects or artifacts belonging to different categories. Sharing the same high percentage of a rare attribute is much more relevant than sharing the same fraction of a very frequent one. Generally speaking, it is straightforward that the presence of a certain category in a given sample is particularly significant when such category represents a larger fraction of that sample than it represents in the whole system. In other words, it is not only the value of the BR coefficient and its likelihood, but also the way such value is achieved. Performing random permutations is the appropriate way to address any kind of size heterogeneity, being it inherent to the samples or the categories. Therefore, if we want to address the latter, we can adopt the same strategy we used for addressing the former, but we need a different comparison. It is not longer the BR value for a given pair of sites that has to be larger than in the randomized samples. Now, it is the number of objects belonging to a certain category that has to exceed the amount we can find in a sample of the same size just as an effect of the action of chance. The categories will be thus labeled as “significant” or “not significant” in each one of the sites, depending on their size, the size of the assemblage in that site, and the presence of objects of that category in it. In Fig. 9A we represent two categories that are not significant in the largest site, i.e., the site of Mainz: *PNN*, with its 19 objects, 7 of which have been found in Mainz, and *AGRICOLAE*, who has a single representative in Mainz, out of a total of 4. In Fig. 9B, we show instead stamp-types that are significant in the same site: *CANTONIQVIETI*, with 13 object out of 20, and *SER*, with 3 out of 3.



**Figure 9. Frequency histogram of four stamp-types in randomized versions of Mainz' assemblage (362 stamps). In panel A (on the left), the stamp-types are PNN(19 stamps, 7 in Mainz) and AGRICOLAE (4 stamps, 2 in Mainz). In both cases, the probability of observing more in a randomized sample is high. In panel B (on the right), the stamp-types are CANTONIQVIETI (20 stamps, 13 in Mainz) and SER (3 out of 3 stamps in Mainz). The probability of observing more in a random sample of the same size is very small.**

In Fig. 10 there is the comparison between two sites, Mainz (size=362) and Butzbach (size=6), where the stamp-type *QIMF* is present with 2 representatives out of a total of 6 stamps. Despite having one third of the total amount of pieces in each of the considered site, given the huge size of the assemblage in Mainz, two objects are not enough to make the presence of *QIMF* significant. This is not the case for the small site of Butzbach, where this category represent one third of the stamps in its assemblage .



**Figure 10. Frequency histogram comparing between two sites, Mainz (size=362) and Butzbach (size=6), where the stamp-type *QIMF* is present with 2 representatives (vertical line) out of a total of 6 stamps. The probability of finding more in a randomized sample is high for Mainz and low for Butzbach.**

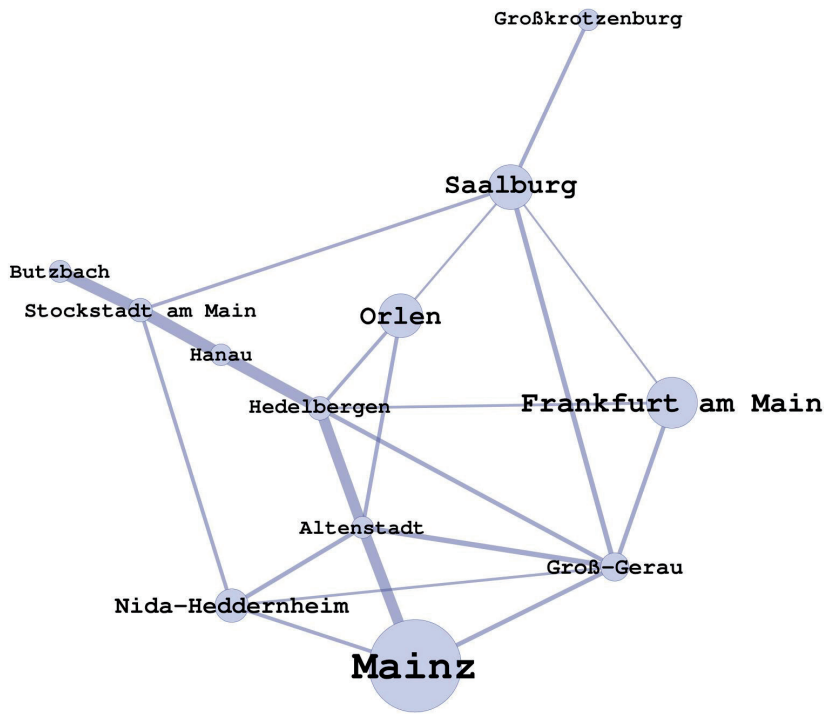




the Jaccard Index (JI) [cit 35], a coefficient which measures similarity between finite sample sets and is defined as the size of the intersection divided by the size of the union of the sample sets:

$$JI(i,j) = \frac{|\{\text{significant categorical attributes in } i\} \cap \{\text{significant categorical attributes in } j\}|}{|\{\text{significant categorical attributes in } i\} \cup \{\text{significant categorical attributes in } j\}|}$$

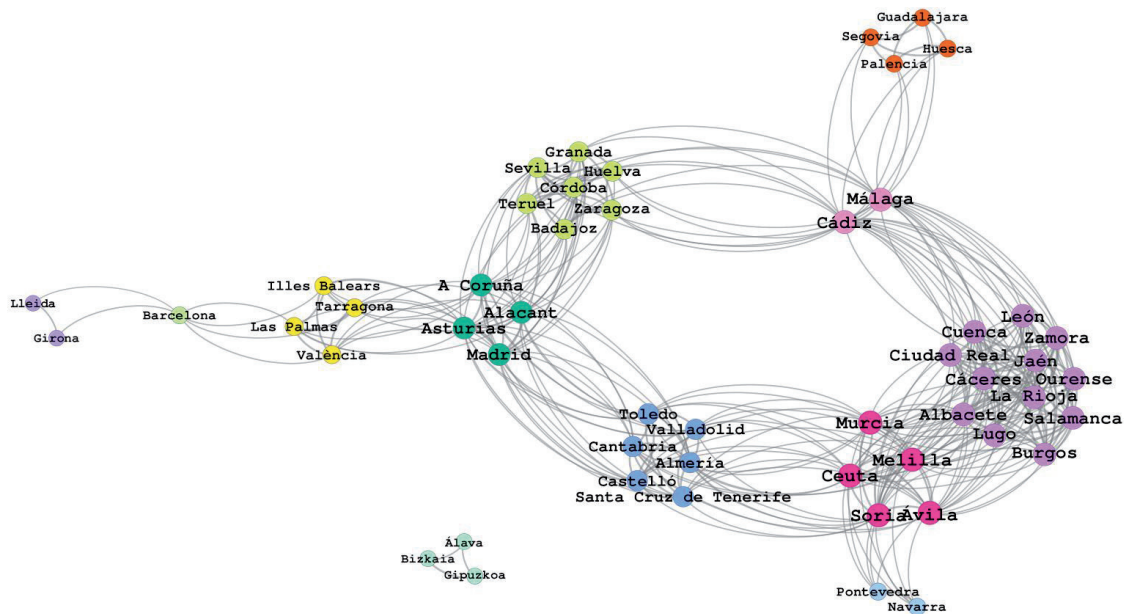
that is the ratio between the categories that are in both sites and the total number of those that are in one or another of the two places considered. This measure takes values between 0 and 1. It is equal to 1 when all the categories in the two lists are the same and 0 when there is no concurrence.



**Figure 12. GS network of places constructed according to the JI. Node pairs connected by thicker links are those whose JI is larger. Disconnected pairs have null JI value. The size of the nodes are proportional to the size (number of stamps) of the corresponding assemblages.**

Although this approach does not tackle size heterogeneity among assemblages directly, it does prevent large sites from acquiring a massive number of connections. This method is designed to unravel the hidden modular structure of the similarity network, if it has one. It connects nodes sharing attributes that can be regarded as typical from the corresponding sites, where typical means overrepresented compared to the random hypothesis. If there is no modular structure, if there are not groups of nodes sharing something that is not common in the rest of the system, or at least does not dominate the attributes distribution with the same force outside the boundaries of some cluster of sites, then this approach cannot be applied. Applying it to a system that has no pattern to unveil is pointless.

In the case of dataset DP, we have applied each of the three methods, thus reconstructing three different similarity networks. The first two networks resemble each other very closely and the second one can indeed be regarded as a validation of the first. We find three small clusters of outsiders. Two of them are characterized by local categorical attributes, that is, political parties that are not present in the rest of the system. The third group is characterized by minimal diversity, having only one category represented in it. The bulk of the network is composed by nodes (districts) where at least two of the most common categories (parties) can be found. The network obtained through the third method (Fig. 13) is remarkably different. Nevertheless, we can clearly interpret what we observe. This last method is able to ravel the fine structure hidden inside the bulk. Districts group together based on which parties, one or two at most, have better results compared to how they perform in the rest of the system. Clusters with two significant categories are connected to the clusters where only one of them is significant. Such intra-cluster links, however, are weaker than those connecting nodes inside the same group. The outsiders still form their own clusters, but those characterized by low diversity are now connected to other clusters where the same category dominates. By combining the two network representations, the one offered by the BR similarity measure and the other obtained by focusing on local specificities of single sites, we have the whole picture. The differences are not contradictions, they bring complementary information about the system under study.



**Figure 13. DP network of districts constructed according to the JI. Node pairs connected by thicker links are those whose JI is larger. Disconnected pairs have null JI value.**

The case of GS is more complicate. There are no well-defined clusters and the correspondence between the two networks is not easy to read. However, all the strongest links in the network inferred accordingly to the third method are also present in the other network.

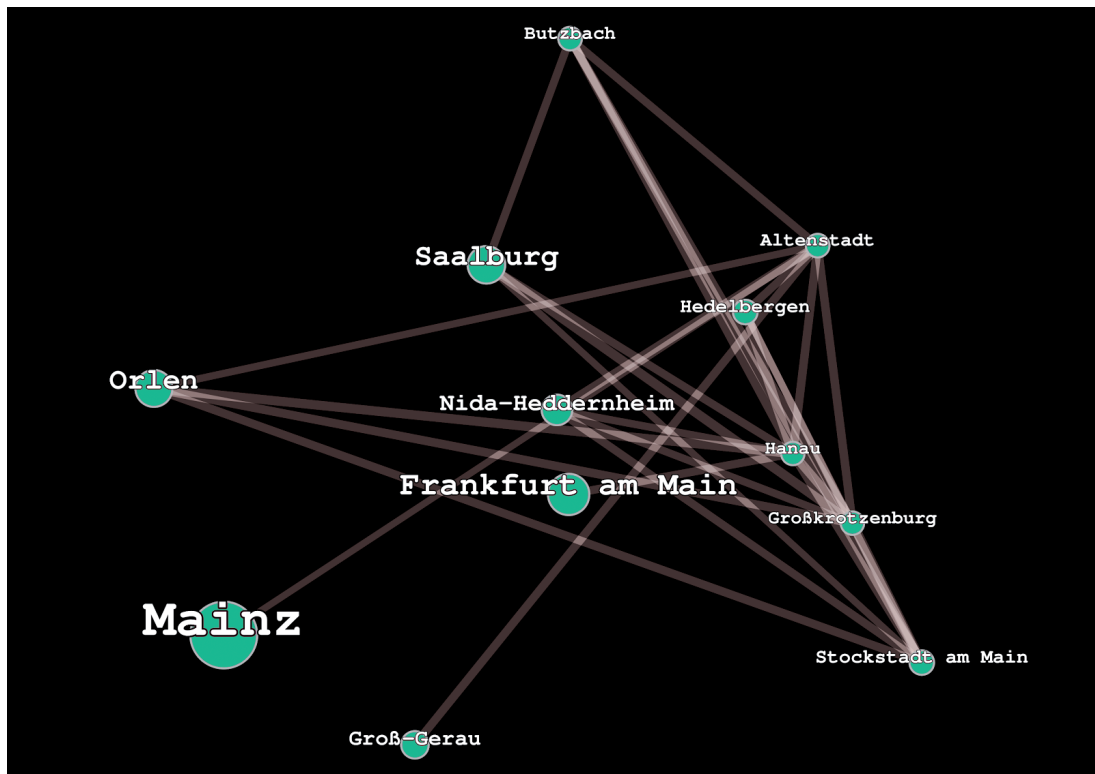


Fig. 14. Geolocalized version of the network in Fig. 8.

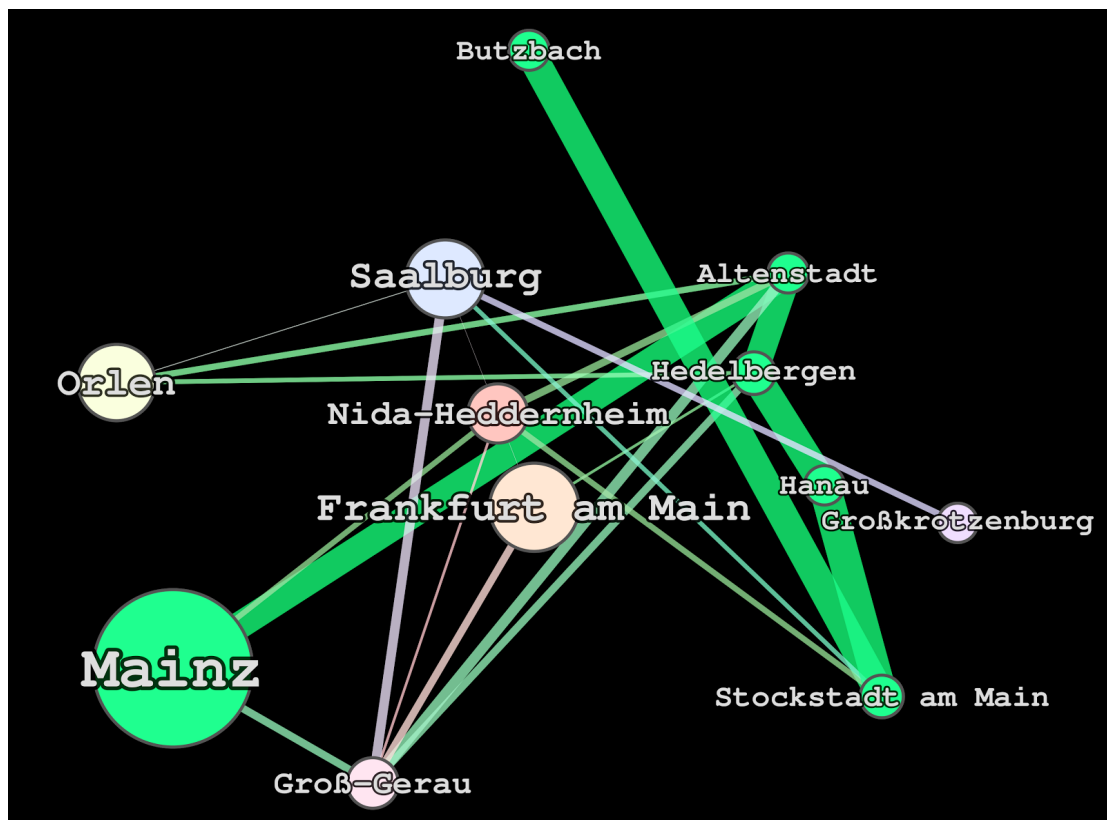


Fig. 15. Geolocalized version of the network in Fig. 12.

Looking at Fig. 14 and Fig. 15, we can clearly recognize a – rawly speaking – North-South axis that goes from Butzbach to Stockstadt am Main, including Altenstadt, Hedelbergen, Hanau, and Großkrotzenburg. On the other hand, the only certainty we have about East-West connections, are the links converging from Mainz and Orlen on the west side, to Altenstadt, in the east. Additionally, it is worth noting that, except for the nodes of the North-South axis, sites on the border of the province are almost never connected to each other, not even to the closest one. In particular, there is no evidence that the similarity between Mainz and Orlen is statistically significant, independently of the adopted approach. Actually, three of the four largest sites in the region – Mainz, Frankfurt am Main, and Orlen – are never connected to each other. The only exception is Saalburg, that has two weak links with Orlen and Frankfurt due to the presence of a significant amount of *MMCSANTO* and *ACIRGI* stamp-types, respectively.

Given the data available, this is as far as we can go. We can gain interesting insights, but the complete connectivity pattern is out of reach. However, this dataset demonstrate beyond any doubt that the absolute value of a similarity index is, *per se*, meaningless. The first similarity network we built has nothing to do with the other two. When we deal with data characterized by a high level of heterogeneity, both in the size of the assemblages and in the size of the categories, without knowing whether the survived samples are representative of the original proportion of attributes in the sites, statistical tests are an unavoidable part of network inference. It is the only way we have to separate information from illusions created by the action of chance, that is, actual signal from background noise due to heterogeneity, incompleteness and uncertainty.

## CONCLUSIONS

Network science has great potential to offer to archaeology and history, but the foundation stone for any application of its tools and analytic techniques is a well grounded network construction. This means that we need a coherent definition for boundaries and nodes and we have to infer the connectivity pattern in a reliable way.

Up to now, an established theoretical framework to deal with the specific combination of difficulties presented by archaeological data has not been completely developed. Network science toolbox does not include a general method to translate incomplete heterogeneous categorical data into probability of connection. Such methodology should be tested on a large number of datasets with different properties, including more recent datasets that can be artificially damaged.

Afterwards, we need to learn how to extract useful information from this probabilistic networks. Uncertainty at the link level does not, in principle, prevent from knowing which are the most important nodes, or how they group together, or whether the system is fragile or robust, easily navigable or likely to congest, centralized or distributed. Statistics may help integrating network science techniques. However, we should also be able to quantify how reliable our conclusions are.

This contribution represents a first attempt at outlining a long term research program.

A great effort needs to be devoted to this enterprise in next years. It is hard to say how long it will take, but we believe that interdisciplinary research teams, involving network scientists, archaeologists, and historians, gather the necessary expertise to accept the challenge.



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## **THEORY-BUILDING OF SOCIAL CHANGE USING COMPUTER SIMULATION**

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### **1 INTRODUCTION**

Historical sciences have now a rich trajectory of applying computer simulation to answer research questions. They provide the needed methodological tools to evaluate complex scenarios where non-linear trajectories unfold over long-term time spans and where the contingency of events is central.

These computer models have been often classified in three types based on their goal: a) hypothesis-testing, b) tactical simulations and c) theory-building. Most models follow the first option, which allows the research to evaluate the plausibility of working hypotheses against empirical evidence. The second option is focused on testing methodological challenges of the different discipline.

This work examines the epistemological and methodological challenges posed by computer model and simulation in History and Archaeology in general and why we think they can be fruitfully uses to study History by comparing it with Evolutionary Biology.

We focus here in the third type, which explores abstract scenarios with the aim of generating new ideas and knowledge using a stylized model of the studied system. While it is true that any hypothesis needs to be finally tested against evidence, the heuristics utility of these theory-building in other scenarios clearly shows the potential of this approach for any scientific discipline.

We will exemplified the utility of this kind of model by presenting an Agent-Based Model exploring the co-evolution of trade and culture within the Roman Empire. This model allows us



to explore the dynamics of a simple goods exchange economy under different cultural network constraint.

## 2 GENERAL ISSUES

### 2.1 Evolutionary Biology

Incompleteness and uncertainty of the historical and archaeological record affect historical interpretation [1] but *formal modelling* and computer simulation are valuable tools to overcome such limitations.

Evolutionary Biologists have successfully embraced these tools long time ago and we think that their epistemological framework is close enough to what archaeologists and historians do to be used as an example to follow.

Indeed, the goal of Evolutionary Biologist is to understand the mechanisms at the origin of the living world as we can observe it. To do so and assuming the theory of evolution by natural selection, they characterise the succession of past events that constitute the Story of Life. Starting with Gould [2], several biologists and philosophers have argued that the nature of this research activity is historical [3]: the actual biological world does not depend *only* on biological rules, but on the uniqueness of the succession of events. To encompass the issues raised by such historicity, evolutionary biologists have developed, since the biometricians and later during the modern synthesis, formal models that help them to explain the patterns they observe in the biological world. From those formal model, they can figure out different possible successions of events and the likelihood of such possible historical paths given wide range of different data.

If at first those model were only formal model described as mathematical equation (Wright-Fisher genetic drift model, Hardy Weinberg equilibrium. . . ) the apparition of computer and their spread in Science in general offered biologists new ways to describe the biological world and computational power to explore area impossible to study by other traditional analytics mean (the huge amount of data generated by Genetics and the quick development of Bio-informatics to manage such data is a good example). Thus, the computational approach was quickly and widely embraced by all fields of Biology in at least to way: (1) to simulate and derive complex dynamical formal models and compare them (numerical simulations), (2) to describe systems where the main properties emerge from the interactions between the subparts of the system and are difficult to describe mathematically (computer modelling).

By the very nature of the object studied (succession of events producing complex patterns), Evolutionary Biology and History are very close. We think that the tools and methods developed in the first context can and should be applied to study historical problems. In the following section we will focus on the second type of computer simulation and we will show why they can be of particular interest for historian and archaeologist.

### 2.2 Computer Simulations and Modelling

As we said before, Evolutionary Biologist use computer simulations for at least two things. Numerical simulation, that allows biologist to simulates complex mathematical model and select between them (as done by people doing Bayesian inference in phylogenetic for example) is already well used by historians and archaeologists (cf [4] for example). But, in complex systems where the

interactions of every subcomponents are multiple, such as in human society where the social-cultural environment interacts with biological and economical evolution, or in Evolutionary Biology where the interaction between development, environment and evolution are central, the global dynamics emerge from the interactions of the subparts of the systems. These subparts are often heterogeneous in nature and are interacting in complex retroacting loops making such system difficult to predict analytically and to describe with simple mathematical equation. This make computer modelling (using algorithmic description of the model) one of the best suitable tool to explore and study those mechanisms.

We think that those problem apply to history and archaeology and we want here to argue in favor of such models. We will give the example of one of them in the following section.

This use of computer simulations and modelling is not restricted to Evolutionary Biology. It is widely spread in all branches of Science and people studying computer simulation per se, in the field which is commonly called “artificial life” [5] have already thought about simulation and computer model. They have proposed different classifications of computer model the one we want to use have often been described as “conceptual model” ([6]. Such computer model are powerful heuristic tools that combine the exploratory power of thought experiments and the logical strength of mathematics [7]. They allow to test quickly a lot of possible “opaque though experiments” that would be impossible to execute mentally. As though experiments, they offer to experimenters a freedom impossible to reach with traditional experiments doing measures directly on the object of study (galaxies in physics, human in psychology, . . . ), while as running on computer, they can handle operation lasting very long timespan and involving range of parameters that one could not handle with his own mind.

They are the perfect tool to generate new hypothesis when few have been proposed, as they allow to deeply explore and compare models and theories without relying on particular data. We think that this is particularly relevant in history and archaeology, where the traditional inductive approach is strongly data driven whereas the uncertainty and the quality of the data cannot really support any of the induced hypothesis and often lead to strong equifinality (many hypothesis can explain the same observed pattern).

Conceptual computer models seen as thought experiments provide us an artificial lab that can guides us through equifinality problems, helps us to generate new hypothesis and provides formal arguments to support hypothesis that can hardly be supported by insufficient empirical evidences.

However, building computational simulations that can provide valuable knowledge about the target system still remains a difficult task. Computer scientists have to be aware of every assumptions they could implicitly made and domain experts (as historians or biologists) have to formulate their hypotheses in an epistemological framework yet not clearly specified and far from the one they are used. The communication is thus primordial: knowledge here does not lie in the mathematical models neither in the historical data but emerges from the well articulation of both side [8].

We will shown one example of a model that could be used by historians and archaeologists in order to help them to test and generate hypotheses. This model is very general and doesn't incorporate knowledge about a particular target system (in contrary to [9]). It allows us to explore general idea about economy and cultural transmission and their interactions in a innovative way, that does not depend on one particular dataset or on particular historical point of view. Moreover it can integrate already formalized model from any other discipline and any knowledge from history and archaeology, to cognitive sciences and economy. It thus gives us a way to weight the likelihood of

trillion of different scenarios that will help then to generate new hypothesis about historical process where few hypothesis have been made or where knowledge isn't good enough to build formal model.

### 3. EXAMPLE OF A COMPUTER MODEL TO STUDY CO-EVOLUTION OF TRADE & CULTURE

This section presents an example of a model to study the co-evolution of cultural change and trade. This model was designed to propose a trade-off between the flexibility necessary for the test of multiple models, that could be based on historical and archaeological assumption, hypothesis and observation and/or actual knowledge on cognition, economy, network theory and so on. This implements the opaque thought experiments we described earlier. It gives us the structure necessary for the in-depth exploration of some general hypothesis made on the transmission of culture and the evolution of economy without relying on one particular dataset or historical knowledge ; and allows for the quantitative comparison between the different models and theories.

To create this framework we propose an Agent-Based Model relying on agents producing, exchanging and associating values to a list of goods. We present the key concepts of the framework and two examples of its implementation which allow us to show the flexibility of our framework. Moreover, we compare the results obtained by the two models, thus validating the structure of the framework. Finally, we validate the implementation of a trading model by studying the price structure it produces.

#### 3.1 Trade & Cultural Evolution

Cultural change comprises the collection of processes that promotes or inhibits the spread of information by social interaction within a population [10]. An increasing number of social scientists are using an evolutionary framework to model cultural change [11]. This approach aims at fostering the development of transdisciplinary efforts designed to understand cultural change.

Within the studies done in the evolutionary framework, a cultural phenomenon (such as music) is viewed as a collection of traits (such as musical genres). Multiple biases (mechanism favouring the use of a cultural trait over an other) can explain the fact that certain of the cultural traits are transmitted more readily than the others. Among the biases studied, some can be explained by the intrinsic properties of a trait (how beneficial it is for the individual using it), while others are explained by the frequency of these traits (how popular a trait is in the culture).

Multiple models can be proposed to represent cultural changes, one of them being the neutral model [12]. Within this type of model it is assumed that a trait does not bias the fitness of the individual that acquires it. It therefore means that no bias modifies the rate of transmission of the cultural traits, and that their success will depend only on their frequency in the population. Within analysis of real data, a neutral model produces a distinctive type of frequency distribution of cultural traits termed *power law*.

The *power law* can be replicated within a virtual setup thanks to a simple random copying transmission mechanism [13]: an individual will copy the traits of a randomly chosen individual with a given probability. This copy can potentially introduce some errors in the acquired trait, which account for *innovation* processes. The individual will in turn continue to spread these cultural traits which will be further adopted by other individuals. This basic model can be enriched by several additional processes both in the innovation [14–16] and the transmission [11, 17]. Unbiased transmission works

as a baseline for identifying frequency-dependent biases: if evidence has higher tendency to copy the most common trait it is known as conformism, while the opposite is defined as anti-conformism.

The archaeological record allows the researchers to identify frequency-dependence biases on cultural transmission over long-term trajectories [18–20]. However, the fact that material culture recovered from archaeological contexts is noisy and fragmented presents some challenges on the validity of the method [21–23].

This work explores the impact of a crucial element on the transmission of material culture: trade. Networks of good exchanges are being increasingly recognised as key elements that structured ancient societies [24–26]. The scenarios where this process emerges suggest a complex bias in the selection of cultural traits, which at the same time are also identified as economic goods [27, 28]. Transmission is not neutral anymore, as different prices for each good will introduce a dynamic content bias. This affects the frequency of the good within the population, which in turn modifies its price following a co-evolutionary dynamic.

These dynamics are studied using an Agent-Based Model (ABM), a type of simulation particularly useful for studying non-linear dynamics in heterogeneous environments within an evolutionary perspective [29]. More precisely we propose a framework that can be implemented in multiple ways depending on the model tested. Next subsection defines the framework, which is based on the basic processes found in evolutionary models cultural change. Next, we define the implementations used to explore the dynamics of the created framework. the following subsection we analyse the results obtained with these two implementations. Finally, the concluding remarks discuss further possibilities of the presented framework.

### 3.2 Framework Description

To explore the co-evolution between trade and cultural change we have developed a framework where the different agents produce and trade goods to which they assign variable values. The model is composed of a population  $Pop$  of  $m$  agents, each defined by 2 vectors of size  $n$ . The first corresponds to the quantity of each good owned by the agent  $i$ :

$$\forall i \in Pop, \quad Q^i = (q_1^i, \dots, q_n^i)$$

where  $Q^i$  is the total list of possessions of agent  $i$ , and  $q_{ij}$  is the number of goods of type  $j$  that agent  $i$  possesses. The second vector reflects the estimation of the value of a good made by an agent  $i$ :

$$\forall i \in Pop, \quad V^i = (v_1^i, \dots, v_n^i)$$

where  $V^i$  is the total list of estimated values of agent  $i$ , and  $v_j^i$  is the value that agent  $i$  associates to one unit of good of type  $j$ .

On top of these elements five processes are used: production, consumption, cultural transmission, innovation and trade. The production process describes the creation of goods by the agent. Once a good is produced by an agent  $i$  it is added to its quantity vector ( $Q^i$ ). The consumption strategy of these goods is defined in the consumption process which decreases the number of goods



in the vector ( $Q^i$ ). In this model, all goods are completely consumed at each iteration for all the models tested. The trade process models the exchange of goods between the agents which results in a modification of the quantity vectors ( $Q^i$ ). The amount of goods exchanged is computed by the agents involved in the trade, within the trade process, based on their value vectors ( $V$ ). Within the *cultural transmission* process an agent  $i$  can copy the entire value vector ( $V$ ) of an agent  $j$ , where  $i \neq j$ . Finally, the *innovation* process also modifies the value vector  $V$  of an agent, but it differs from the *cultural transmission* process in that the modification is done without reference to the other agents.

The scheduling of the five processes is described in algorithm 1 along with the vectors modified by each these processes. On lines 3 and 4 all agents of the population are initialised with empty quantity vectors and random values. The code used to update the status of each agent at each iteration is presented between the lines 8 and 22. One can note that each of the five processes is executed synchronously by all agents. Moreover, the trade process is called at each iteration while the *cultural transmission* and *innovation* processes are executed only every *CulturalStep*. The idea behind this is to perform the *cultural transmission* based on a score that reflects the performance of the agent and not only one lucky or unlucky trading round. The timestep number used in all the figures presenting the results of this model refers to the number of times the *cultural transmission* and *innovation* processes are called.

In order to validate our model we first reproduce common results from the literature on *cultural transmission*. We then show that it is possible to transform our model to fit processes that are economically sound, *i.e.* the model should show the convergence optimal values such as shown in [30]. To achieve these two goals, we have designed for each one a specific set of implementations of the five core processes (*production, consumption, trade, cultural transmission* and *innovation*).

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**Algorithm 1** Model

---

```

1: INITIALIZATION:
2: for  $i \in \#Pop$  do                                ▷ Initialize the agent with no goods and a random value vector
3:    $Q^i = (0, \dots, 0)$ 
4:    $V^i = (v_0^i, \dots, v_n^i)$                         ▷ The values of  $v_j^i$  are selected randomly
5: end for
6: SIMULATION:
7: loop  $step \in TimeSteps$ 
8:   for  $i \in Pop$  do
9:      $Production(Q^i)$ 
10:  end for
11:  for  $i \in Pop$  do
12:    for  $j \in Pop$  do
13:       $TradeProcess(V^i, Q^i, V^j, Q^j)$ 
14:    end for
15:  end for
16:  for  $i \in Pop$  do
17:     $ConsumeGoods(Q^i)$                                 ▷ All goods are consumed
18:    if  $(step \bmod CulturalStep) = 0$  then
19:       $CulturalTransmission(V)$ 
20:       $Innovation(V^i)$ 
21:    end if
22:  end for
23: end loop

```

---

### 3.2.1 Neutral Configuration

The first scenario is designed to reproduce unbiased transmission, where each good is a cultural trait without intrinsic positive or negative weight [13,27,31]. Under this hypothesis, the processes of *production* and *trade* are not relevant, and as a consequence, they do not modify the content of the quantity vectors of the agents.

Unbiased cultural transmission is implemented using “random copy”: each agent has a low probability to pick randomly one agent among all and copy its vector of values. The innovation process, termed “unbounded”, is triggered with a low probability ( $\mu$ ) and draw a new random value to replace an element  $v_j^i$ .

The neutral hypothesis states that the “random copy” transmission and the “unbounded” innovation process used under a fixed population size leads to a distribution of frequency of cultural variants termed *power law*. This distribution is characterized by a small number of very frequent traits and a large number of rare traits. The main difference with similar distributions, such as exponential distribution, is that the rare traits are far from being absent of the distribution, *i.e.* the tail of the distribution is large.

This distribution is formalised as :

$$P(v) = C/v^\alpha$$

where  $v$  is the number of times a variant has been repeated,  $P(v)$  the probability to find that variant,  $C$  a constant,  $\alpha$  a variable describing the slope of the curve obtained. We will therefore attempt to fit as well as possible the results obtained with this set of implementations to the “power law” distribution by modifying the  $\alpha$  parameter.

### 3.2.2 Trading Biased Configuration

In the second scenario, we are interested in the exchange of goods between agents in a barter process where each agent can choose its prices of exchange. We want to implement simple processes leading to the convergence of all prices to values acceptable by all agents, *i.e.* we would like to observe, at the end of an experiment, all the agents using a set of prices which allow them to trade efficiently

**Production:** Each agent produces one good. The type of good produced by an agent  $i$  is assigned to it at the beginning of the simulation, does not change through the simulation, and is referred to as *produced<sup>i</sup>*. At each time step, each agent, produces a number of units (of its production good) equal to the number of goods, which ensures that enough is owned to be traded for other goods. Moreover, when an agent consumes its own production good, it does not impact its inventory.

**Cultural transmission:** Social learning is here biased towards the agents which are the best at trading, and is therefore termed “success bias”. To achieve this bias, the cultural transmission mechanism used takes intoaccount the value vector of the other agents and relies on two new notions: need and score.

The *need* is a quantity of good that each agent tries to obtain. This quantity is different for each good but the need for a good is the same for all agents:

$$N = (n_p, \dots, n_r)$$

The score  $s_j^i$  of an agent  $i$  reflects the ability of this agent to obtain the quantity of good  $j$  it needs. It is maximum when the quantity  $q_j^i$  that an agent  $i$  owns of the good  $j$  is equal to the need  $n_j$  for the good  $j$  and lowers proportionally to the distance between the need vector and the quantity vector. It is calculated in such a way that each good has the same weight in the final score, *i.e.* managing to get only the right amount of a good with a high “need” value will not give a better score to the agent and its formal description is given in the Annex.

The complete score of an agent  $i$  is termed  $s_i$  and corresponds to the sum of the  $s_j^i$ . An agent will choose from whom the price vector should be copied among the agents that produce the same good and have the highest score. In practice, the worst (in terms of score) 20 percent of the agents producing the same good will copy the prices of the best twenty percent producing the same good. The algorithmic description of this selection process is given in the Annex with the algorithm 2.

**Trading:** During the trading phase the value associated to a good by an agent corresponds to the subjective price of the good for this agent. Briefly summarised, for each good that it does not produce, an agent will trade with the first partner that offers an acceptable trade, *i.e.* an agent that proposes a satisfiable ratio between the other good and the good produced by the agent.

If a trade is possible, the two agents will exchange the agreed quantities. If the trade is not possible, the agent will continue to look at random partners for this good until either a partner is found or *TradeThreshold* agents have been tried. At this point the agent will try to trade with agents producing another good. The process goes on until all goods have been tried. This trading process is described in the algorithm 3 in the Annex session

**Innovation:** In a trading environment it seems unlikely that a price will change radically to a very different value. Therefore, a new and more realistic mechanism is proposed. The innovation process, coined “self referenced”, is still triggered with probability  $\mu$  but modifies the previous price by adding or subtracting a small amount taken randomly from a uniform distribution between  $0.. \beta$ .

**Expected outcome:** Based on the set of implementations presented and given the equations (3) and (4), it is expected that the prices will converge to value allowing each agent to obtain quantities of resources exactly equivalent to the needs. The best possible price of all good satisfies the equations :

$$\begin{aligned} \frac{v_k^o}{v_g^o} &= n_k \\ v_g^o &= n_g \end{aligned} \Rightarrow v_k^o = n_k \times n_g, \quad \forall k \in Goods, \forall o \in Pop, g = produced^o, k \neq g \quad (1)$$

Which means that

$$\forall j \in Goods, \forall i \in Pop \quad \tilde{v}^i = \begin{cases} \tilde{v}_j^i = n_j & \text{if } j = produced^i \\ \tilde{v}_j^i = n_j \times n_{produced^i} & \text{else} \end{cases} \quad (2)$$

If such prices are reached, given the exchange rules defined in (4) and the exchange constraints (5) and (6) all exchanges will be optimally achieved, leading to a total score  $S$  for each agent of the population :

$$S = \sum_{i=0}^{CulturalStep} s^i(\tilde{Q}^i) \times ngoods$$

where  $\tilde{Q}^i$  is the optimal quantity vector, *i.e.* the one for which  $s^i(\tilde{Q}^i) = smax$  . Remember that from equation 3,  $smax = 1$ .

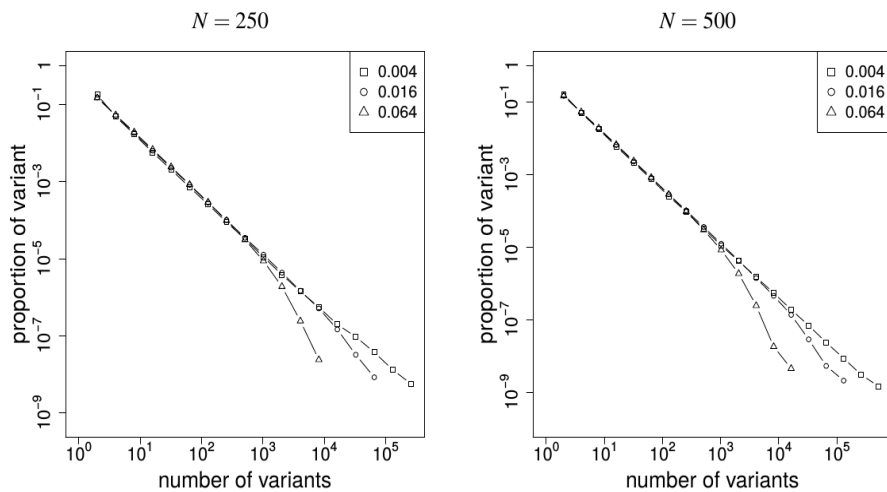
### 3.2.3 Experimental setups

The neutral model is tested through 15 experimental setups. The first six experimental setups are using 1 good, two population sizes (250 and 500 agents) and three values of  $\mu$  (0.004, 0.016 and 0.064). The remaining experimental setups are using 500 agents, 3 number of goods (3, 6 and 9) and three values of  $\mu$  (0.004, 0.016 and 0.064). For each setup, we have performed 100 runs of 10000 timestep each. The trading model is tested on an experimental setups using 3 goods, 500 agents and  $\mu$  equal to 0.004. Again 100 runs of 10000 timesteps are performed. The experiments, as well as the parameters used to run those experiments, are available online [32] for the Pandora simulator [33].

## 3.3 Results

### 3.3.1 Neutral Model

We first analyse the result obtained in the “neutral model” with one good. The figure 1 presents the results obtained for two population sizes  $N$  (250 and 500 agents) and  $\mu$  varying through three values (0.004, 0.016, 0.064). The figure is a log-log plot of the average (across all the runs) of the distribution of variants obtained through all experiments. The y-axis shows the proportions of the variants of the prices used during the simulation, the x-axis shows how many variant achieves such proportions.



**Figure 1: Distribution of proportions depending on the  $\mu$  parameter with 250 agents (left) and 500 agents (right). Each plot is the mean obtained for 100 runs.**



We observe that the lower the mutation rate, the closer to a line the result is. This line corresponds to the “power law” distribution explained in subsection 3.2.1, and is typical of the result obtained under the “neutral hypothesis”. In order to verify if the distribution is in fact a power-law, we follow the method proposed by [34] and the R implementation proposed by [35]. Briefly, two values are returned: a) the estimation of the  $\alpha$  parameter of the power law equation  $P(v) = C/v^\alpha$ ; b) a  $p$ -value testing the null-hypothesis that our data could have been generated from a power law distribution.

The table 1 summarizes the results obtained on all setups. Each value shown in the table is the mean values of 100 simulations. We see that in almost every case the null hypothesis cannot be rejected, which means that indeed the repartition of the price follows a power law. The only exception is for  $\mu$  equal to 0.064, where the  $p$ -value is less than 0.05. In this last case the null hypothesis is rejected, and we therefore assume that the distribution does not follow a power law.

*Table 1: Mean  $\alpha$  & sd are calculated on 100 runs for our results, and 5 runs for Bentley et. al. 2004. pr is the percentage of run for which the  $p$ -value is less than 0.05, i.e. the percentage of runs for which we rejected the null-hypotheses stating that the distribution follow a power law.*

N	$\mu$	Our result		Bentley et. al. 2004
		$\alpha$ (sd)	$p$ -value (sd - pr)	$\alpha$ (sd)
250	0.004	1.53 (0.03)	0.58 (0.24 - .01)	1.54 (0.02)
	0.016	1.57 (0.02)	0.35 (0.28 - .05)	1.57 (0.01)
	0.064	1.66 (0.01)	0.0 (0.00 - 1)	1.67 (0.01)
500	0.004	1.50 (0.02)	0.59 (0.28 - .02 )	1.53 (0.03)
	0.016	1.55 (0.03)	0.15 (0.17 - .10 )	1.61 (0.04)
	0.064	1.78 (0.08)	0.0 (0.00 - 1)	1.81 (0.10)

For comparison purposes the results obtained by [13] (which tested the “neutral hypothesis” with the same methodology) are added in the last column of table 1.

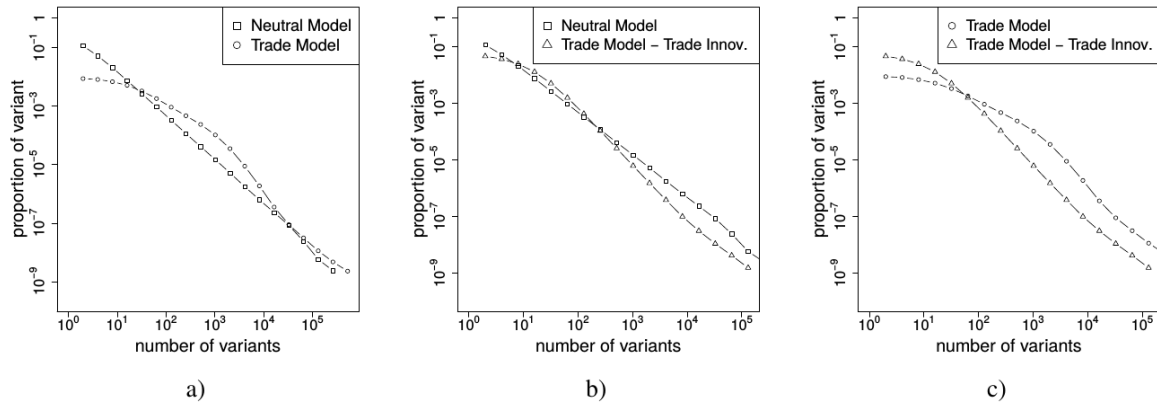
It allows us to statistically test our model and to compare it to other already existing in the literature. We show here that our model is consistent with the existing literature and thus with already observed and known social phenomenon.

### 3.3.2 Distribution of variants

In order to understand the effect of introducing trading mechanisms, we compare first the distribution of values obtained in the “trading model” against the values obtained in the “neutral model”. The figure 2.a) presents the results obtained from 100 runs for each model. All runs rely on the same experimental setup using 3 goods, 500 agents and  $\mu$  equal to 0.004. In all following graph a variant is one price of one given good. The distributions are first computed for each good independently and then averaged together.

On figure 2.a) it appears that the implementation of trade mechanisms leads to a distribution of prices departing from the neutral hypothesis. In more details, the frequencies distribution has a plateau of common prices (a number of prices share similar and high proportions), which shows that, when trade is taken into account, the most common variants are more diverse.

In order to investigate which mechanism influences this departure from the neutral model, additional investigations have been performed. Here is presented the results of the analysis on the effect of the innovation process of the trade model. To conduct this analysis the innovation process of the trade model has been replaced by the innovation process of the neutral model. 100 runs have been performed with this model on the same experimental setup. The results obtained are compared to the neutral model in figure 2.b) and to the trade model in figure 2.c).



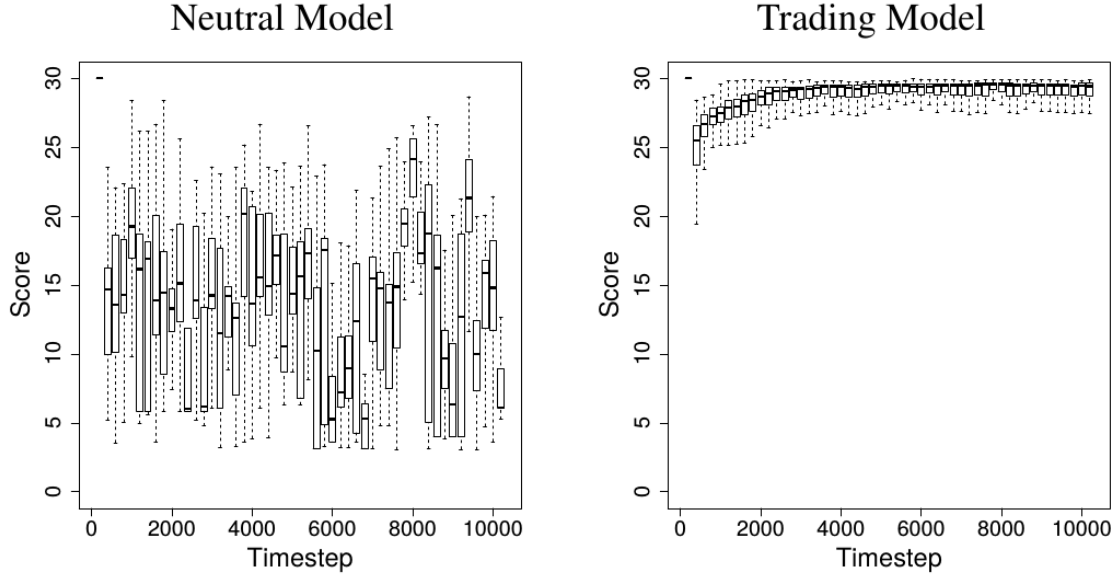
**Fig020**Frequencies distribution, where each points represent the mean for 100 runs, for: a) the neutral and the trading models. b) the neutral model and the trading model without the trading innovation process. c) the trade model and the trade model without the trading innovation process.

On figure 2.b) it appears that the replacement of the innovation process leads to the creation of a distribution close to the one obtained with the neutral model. On figure 2.c) we observe a strong reduction in the size of the plateau and an important difference between the two distributions. This analysis highlights the importance of the innovation process of the trading model in the distribution of prices. This mechanism, by preventing the creation of totally random new price, promotes the creation of few similar prices.

Moreover, it shows how the implementation of one particular trade mechanism can be tested and compared to an already well know model that is already used to understand available data. This suggests we could easily implement others trade mechanism, inspired or documented by archaeological data or historical sources, and compare their expected impact on the cultural distribution with regard to traditional cultural mechanism or other trade mechanism as those presented here.

### 3.3.3 Study of scores

The results obtained with the trade model are studied in more detail by investigating the ability of the population to find the price most suited for exchanges. This is done by first measuring the score of all agents in each of the two different models. The figure 3 uses again the results obtained from 100 runs for each model where all runs rely on the same experimental setup using 3 goods, 500 agents and  $\mu$  equal to 0.004. The figure is showing, as boxplots, the score computed thanks to equation (3) for all agents of all runs. The y-axis shows the score computed and the x-axis shows the timesteps. The left plot shows the results obtained in the “neutral model” and the right plot shows the results obtained in the “trading model”.

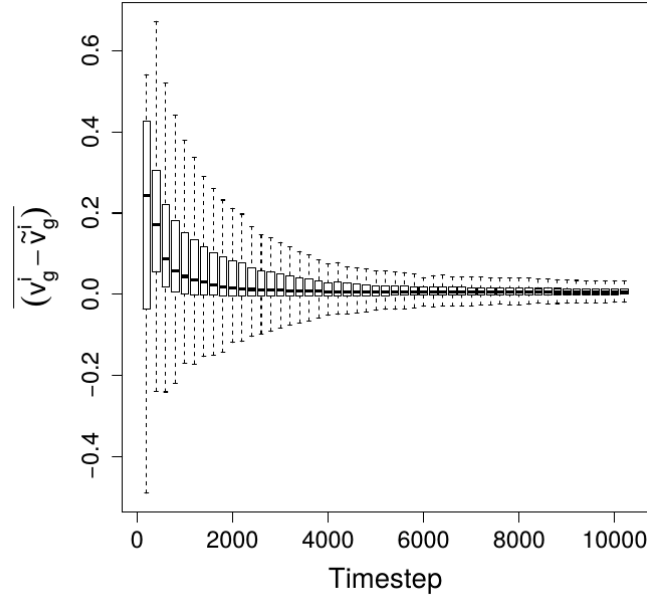


**Fig030** Evolution of the score within the two different models for two typical run with 500 agents and 3 goods evolving during 10000 timestep.

As expected, the scores within the neutral model vary randomly. “Trends” may appear, where a bigger proportion of individuals adopt a better price that allow agents to reach better score (such as around iteration 8000), but such good score fall back as soon as another trend appears. However, with the trading model, the score of all the agents increase. As the selection mechanism allow them to know who has found better vectors of prices, they will progressively adopt prices vector that allow all of them to reach better scores.

The previous figure showed the capacity for the trading model to increase its score but did not analyse the exact prices used. As explained in the subsection 3.2.2 we expect that the trade cultural transmission and innovation processes will produce a convergence toward a set of price for each good that will allow agents to exchange optimally the good they produce with the other goods. To verify this assumption we analyse the prices reached during the simulations. These are presented in figure 4 for the 100 runs relying the experimental setup using 3 goods, 500 agents and  $\mu$  equal to 0.004. For all runs, all agents and at each iteration we compute the difference between the price used by the agent  $V_g$  and the optimal price  $\tilde{V}_g$  (given by equation 2). The measures performed are presented as boxplots condensing the results for 100 runs.

We observe that prices are indeed converging to the optimal prices which means that the agents within the trading model are indeed improving their scores by reaching the optimal prices. Notably, a similar variation of prices was observed in the closely related economical model of [30]. This variation of the prices to the optimum offers an additional conformation of the validity of the trading model.



**Fig040 Evolution of the mean of the difference between the estimated value  $v_g^i$  and the optimal value  $\tilde{v}_g^i$  (calculated with equation 2) for a good  $g$  and an agent  $i$ . As the optimal value  $\tilde{v}_g^i$  depends on which good is produced by  $i$ , the mean of the difference between the estimated price and the optimal one is computed between all the agents that produce the same good. The figure represents this mean computed at each timestep for each goods, for each groups of agents and for 100 runs in a setup with 500 agents and 3 goods.**

### 3.4 Summary

With this model we propose a framework to simultaneously study cultural change and trade dynamics. The development of this framework was first aimed at simplicity which is achieved by the use of two vectors (quantity and value) and five processes (production, consumption, trade, cultural transmission and innovation). The second aim of the work conducted was to obtain a flexible framework which is possible since each of the processes can be implemented accordingly to the question studied. Both objectives were selected to provide a way to implement assumptions, hypotheses and hints made on the cultural and trading environment in the Roman Empire, where the culture dimension was tightly linked to the economics activity. We shown here how simple assumptions made at different level (see our implementation of the production, consumption, trade, cultural transmission and innovation mechanisms described in the Section 3.2.1 and 3.2.2) can be tested and compared. Those simple assumption could then easily be change by other made in the literature [36].

Moreover, we have shown the theoretical validity of this approach by reproducing expected results on both the cultural and trade side. On the cultural transmission side we have shown that the implementation of a “neutral model” leads to the expected observations on the variants of the vector value: a power law. When implementing trading mechanisms we observe the convergence of prices to the expected values and the improvement of the scores of the agents.

## 4 CONCLUSION

In this chapter we have argued that computer model and simulations are a good candidate to help historians and archaeologists in their quest for understanding the past. We have explained such point by taking the example of Biology and by showing that history is a perfect example of what kind of problem simulations can help us to solve and how. We have argued that computer simulations can help historians to select between different models already formalized by running numerical simulation, or they can help historians by giving them a powerful tool to generate “conceptual model”, or “opaque thought experiment” that allows to make hypothesis and assumptions explicit, to explore, compare and generate models of such hypothesis.

We have then extensively illustrated such model with one that we have developed to study the co-evolution of trade and culture and by showing how we can test and already studied such model without relying on particular data.

## 5 ANNEX

### 5.1 Score & Selection

Formal computation of the score for agent  $i$  and the good  $j$ :

$$s_j^i = \begin{cases} s_{max} = 1 & \text{if } q_j^i = n_j \\ 1 - \frac{|q_j^i - n_j|}{\sqrt{|(q_j^i)^2 - (n_j)^2|}} & \text{if } q_j^i \neq n_j \end{cases}$$

---

#### Algorithm 2 Selection Process

---

```

1:  $ToGet = 0.2 \times \frac{\#Pop}{\#Good}$ 
2: for  $g \in Good$  do
3:    $ToReplace = \{\}$ 
4:   while  $\#ToReplace < ToGet$  do
5:      $j = SelectRand(Pop, g)$   $\triangleright$  Select randomly an agent  $j$  among the agents producing  $g$ 
6:      $X \sim U([0, 1])$   $\triangleright$  Draw a random number from the uniform distribution between 0 and 1
7:     if  $X > ComputeScore(j)$  then  $\triangleright$  Select preferably the agents with the lowest scores
8:        $ToReplace = \{ToReplace, j\}$ 
9:     end if
10:  end while
11:  while  $\#ToReplace > 0$  do
12:     $j = SelectRand(ToReplace)$ 
13:     $i = SelectRand(Pop, g)$   $\triangleright$  Select randomly an agent  $i$  among the agents producing  $g$ 
14:     $X \sim U([0, 1])$ 
15:    if  $(X < ComputeScore(i))$  then  $\triangleright$  Select preferably an agent  $i$  with a high score
16:      if  $(ComputeScore(i) > ComputeScore(j))$  then  $\triangleright$  Verify that agent  $i$  has a higher score than
        agent  $j$ 
17:         $CopyPrice(i, j)$ 
18:         $ToReplace = ToReplace - i$ 
19:      end if
20:    end if
21:  end while
22: end for

```

---



## 5.2 Trade Mechanism

The trading phase starts by the agent looking at a first random agent producing another good. Let  $o$  be an agent producing  $g$  who proposes a trade and  $r$  an agent producing  $k$  that receives the proposition. As explained earlier, each has a quantity of good  $Q^o$  and  $Q^r$ . On the one side,  $o$  wants to exchange a quantity  $w_g^o$  of the good  $g$  for a quantity  $w_k^o$  of the good  $k$ . On the other side,  $r$  wants to exchange a quantity  $w_g^r$  of the good  $g$  for a quantity  $w_k^r$ .

The tuples  $W^o$  and  $W^r$  describe the quantities of goods wanted by agent  $o$  and  $r$  for one trade proposition and are defined by:

$$W^o = (w_g^o = v_g^o, w_k^o = \frac{v_k^o}{v_g^o}), \quad W^r = (w_k^r = v_k^r, w_g^r = \frac{v_g^r}{v_k^r}) \quad (4)$$

Where  $v_j^i$  are the estimated value of the good  $j$  by the agent  $i$  as defined earlier. The requested quantity of the non produced good is simply the ratio between the estimated value of the good requested and the estimated value of the produced good.

Once the quantities are defined, the agents declare that the trade is possible if :

$$q_g^o \geq w_g^o, \quad q_k^r \leq w_k^r, \quad q_k^r \geq w_k^o \quad (5)$$

$$w_g^o \geq (q_g^r + w_g^r), \quad w_k^o \leq w_k^r, \quad w_g^o \leq w_g^r \quad (6)$$

The conditions 5 ensure that both agents have enough goods in their inventory to realise the trade while the conditions 6 ensure that the quantities of goods fit the will of both agents.

---

### Algorithm 3 Trading Process for agent $o$

---

```

1: for  $j \in \text{Goods}$  &  $j \neq \text{produced}^o$  do
2:    $\text{tradeAttempt} = 0$ 
3:   for  $r \in \text{Pop}$  &  $\text{produced}^r = j$  &  $\text{tradeAttempt} < \text{TradeThreshold}$  do
4:     if  $\text{acceptableTrade}(W_o, W_r)$  then
5:        $\text{trade}(W_o, W_r)$ 
6:     else
7:        $\text{tradeAttempt} = \text{tradeAttempt} + 1$ 
8:     end if
9:   end for
10: end for

```

---

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## TECNOLOGÍA SEMÁNTICA E INTEGRACIÓN DE DATOS EN EPNET

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### 1. INTRODUCCIÓN

La investigación en el campo de la Historia ha ido incorporando progresivamente el uso de tecnologías semánticas (Hitzler, Krotzsch y Rudolph 2009; Shadbolt, Berners-Lee y Hall 2006; Domingue, Fensel y Hendler 2011) como medio para abordar diversos problemas. Un ejemplo es el hacer explícita la semántica contenida en una fuente histórica, formalizarla y conectarla con la de otras fuentes (Merono-Penuela et al. 2014). En el área denominada *Digital Humanities*, se está empezando a usar dichas fuentes para agregar información de carácter histórico, dado que los recientes avances en computación y herramientas computacionales (desde *machine learning*, hasta estadística aplicada, minería de texto, *topic modeling* y tecnologías semánticas) hacen posible el manipular estos conjuntos de datos de manera que sean comprensibles. Como resultado, durante las últimas décadas se han ido acumulando una gran cantidad de nuevos datos cuantificables, publicados en formatos abiertos, que van desde el campo de las ciencias sociales hasta el de la economía, abriendo así nuevas posibilidades para resolver viejas cuestiones y proponer otras nuevas (Raghavan 2014).

Dado que las tecnología de Web Semántica y *Linked Open Data* han alcanzado un buen nivel de madurez en su desarrollo, tómese como ejemplo los protocolos de intercambio de datos, los lenguajes de representación del conocimiento, y los formatos estándar de datos<sup>1</sup>, se han financiado un número considerable de iniciativas y proyectos públicos con el objetivo de agrupar datos históricos

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<sup>1</sup> W3C Standards, <http://www.w3.org/>



y culturales, y hacerlos públicos a través de la web. Entre otros, los siguientes proyectos son dignos de mención, ya que representan esfuerzos pioneros en la aplicación de tecnologías semánticas en el desarrollo de portales de e-cultura, donde se proporciona acceso multimedia a distintas colecciones de objetos relacionados con la herencia cultural: EUROPEANA<sup>2</sup>, ARIADNE<sup>3</sup>, CULTURESAMPO<sup>4</sup>, STICH @CATCH<sup>5</sup>, MultimediaN N9C<sup>6</sup>, CHIP<sup>7</sup>, EAGLE<sup>8</sup>, CIDOC CRM<sup>9</sup>, GETTY Vocabularies<sup>10</sup>, INCONCLASS<sup>11</sup>, EPIDOC<sup>12</sup>.

Estos proyectos se pueden caracterizar según si persiguen uno de los siguientes dos objetivos: (i) exponer de manera explícita estructuras, conjuntos integrados de datos, vocabularios y ontologías para dar soporte a iniciativas posteriores que se dediquen a diseñar y desarrollar aplicaciones computacionales en el área de *Digital Humanities*, y (ii) representar distintas implementaciones de estas aplicaciones.

Un inconveniente de los modelos desarrollados por los proyectos dentro de la primera categoría es que resultan muy difíciles de comprender por una persona no experta ya que (i) los nombres de los conceptos suelen ser crípticos (por ejemplo, CIDOC CRM usa el concepto ‘E84’ para referirse a objetos con algún tipo de inscripción) y (ii) los conceptos se definen a un nivel muy abstracto para que puedan ser así aplicados en cualquier dominio dentro de las *Digital Humanities* (un ejemplo es el concepto ‘E75’ de CIDOC CRM, definido como ‘Conceptual Object Appellation’).

El proyecto EPNet pone énfasis en proporcionar a los historiadores herramientas computacionales para comparar, agregar, medir, geo localizar y buscar datos acerca de inscripciones latinas y griegas sobre ánforas en el contexto del transporte de alimentos. Este enfoque se basa en el paradigma *Ontology-Based Data Access* (OBDA) que permite integrar de manera virtual distintos conjuntos de datos bajo una capa conceptual (una ontología).

**Ejemplo 1.1.** Supongamos que un usuario quiere obtener todas las ánforas correspondientes a un listado de tipos anfóricos que han sido producidas en ‘La Corregidora’ y ver sus coordenadas geográficas. El conjunto de datos propio de EPNet (base de datos CEIPAC <http://ceipac.ub.edu>) contiene información sobre ánforas y, en algunos casos, las coordenadas de su lugar de hallazgo. Por otro lado, la base de datos Pleiades (<http://pleiades.stoa.org>) contiene una información geográfica más completa, especialmente en lo que se refiere a la disponibilidad de coordenadas, pero no tiene ningún tipo de información respecto a ánforas. Dado que hay múltiples tipos de ánforas, tales como Dressel 1, Dressel 2-4, Leptiminius 1, ... cada uno representado en EPNet por medio de un código alfanumérico distinto, como por ejemplo “DR1C-BTIR”, formular una pregunta directamente a la base de datos que permita obtener la información deseada resulta una tarea bastante compleja. Requiere de un profundo conocimiento de cómo la base de datos codifica cada tipo anfórico, además de cómo los datos están estructurados dentro de cada una de las bases de datos (EPNet y Pleiades). El usuario

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<sup>2</sup><http://www.europeana.eu>

<sup>3</sup><http://www.ariadne-infrastructure.eu>

<sup>4</sup><http://www.kulttuurisampo.fi>

<sup>5</sup><http://www.cs.vu.nl/STITCH>

<sup>6</sup><http://e-culture.multimedien.nl>

<sup>7</sup><http://chip.win.tue.nl>

<sup>8</sup><http://http://eagle-network.eu>

<sup>9</sup><http://www.cidoc-crm.org>

<sup>10</sup><http://www.getty.edu/research/tools/vocabularies>

<sup>11</sup><http://www.iconclass.nl>

<sup>12</sup><http://epidoc.sourceforge.net>

se ve obligado a escribir una pregunta para cada una de las bases, ejecutarlas por separado y luego combinar manualmente los resultados obtenidos. Idealmente, el usuario debería de poder ejecutar una única pregunta sin tener conocimiento de los detalles internos de las distintas bases de datos y obtener una única respuesta con datos provenientes de ambas bases.

De manera diferente a proporcionar acceso a un museo virtual o a colecciones digitalizadas, la implementación de un sistema OBDA por medio de tecnologías y principios acordes al estado del arte en el área de investigación en representación del conocimiento (van Harmelen, Lifschitz y Porter 2007) que presentamos en este artículo tiene como objetivo el dar soporte a los investigadores en la verificación experimental de hipótesis teóricas ya existentes así como la formulación de otras nuevas. Específicamente, este artículo aporta las siguientes contribuciones:

- La introducción del modelo conceptual de referencia de EPNNet.
- La especificación del esquema relacional acorde al cual se almacena el conjunto de datos de EPNNet.
- La definición de una ontología (basada en el modelo conceptual de referencia) y unos mappings, y la descripción de cómo estos permiten implementar el sistema OBDA.
- La descripción de un sistema con interfaz web para responder preguntas formuladas en términos de la ontología.

El artículo está organizado como sigue. La sección 2 proporciona una breve introducción al proyecto EPNNet. La sección 3 describe de manera concisa los distintos artefactos que se han desarrollado durante la construcción de nuestro sistema de gestión de datos basado en ontologías. La sección 4 introduce por medio de ejemplos el marco OBDA que se ha implementado, explicando cómo esta solución afronta los problemas de acceso, integración y consistencia de los datos. En la misma sección se describe una interfaz web preliminar diseñada para testear el sistema. La sección 6 ejemplifica la utilidad del sistema mediante la presentación de una serie de preguntas que el sistema permite ahora responder y cuyo estudio puede resultar interesante desde el punto de vista histórico. La sección 6 concluye el artículo.

## 2. CONTEXTO HISTÓRICO

El sistema de comercio del Imperio Romano está considerado normalmente como la primera red de comercio compleja en Europa, la cual constituía un sistema integrado de interacciones e interdependencias entre la zona del Mediterráneo y el norte de Europa. Durante los últimos dos siglos, los investigadores han desarrollado una variedad de teorías para explicar la organización del comercio durante el Imperio Romano. La mayoría de estas teorías siguen siendo especulativas y difíciles de falsificar (Garnsey y Whittaker 1983; Cascio y Rathbone 2000).

EPNNet pretende establecer un marco innovador para investigar los mecanismos y características del comercio durante el Imperio Romano. El objetivo principal es crear un laboratorio experimental e interdisciplinar (el equipo del proyecto incluye especialistas del campo de Ciencias Sociales, Humanidades, Física e Informática) para la exploración, validación y falsificación de teorías existentes y la formulación de otras nuevas. Este enfoque es posible gracias a (i) un extenso conjunto de datos empíricos acerca ánforas romanas y su contenido epigráfico que ha sido recogido

por el grupo CEIPAC durante las últimas dos décadas (ver, por ejemplo, las figuras 1 y 2), y (ii) la investigación de primera línea desarrollada por los historiadores acerca de los aspectos políticos y económicos del sistema comercial romano.



Fig. 1. Titulus pictus en posición 'delta' sobre un ánfora Dressel 20.

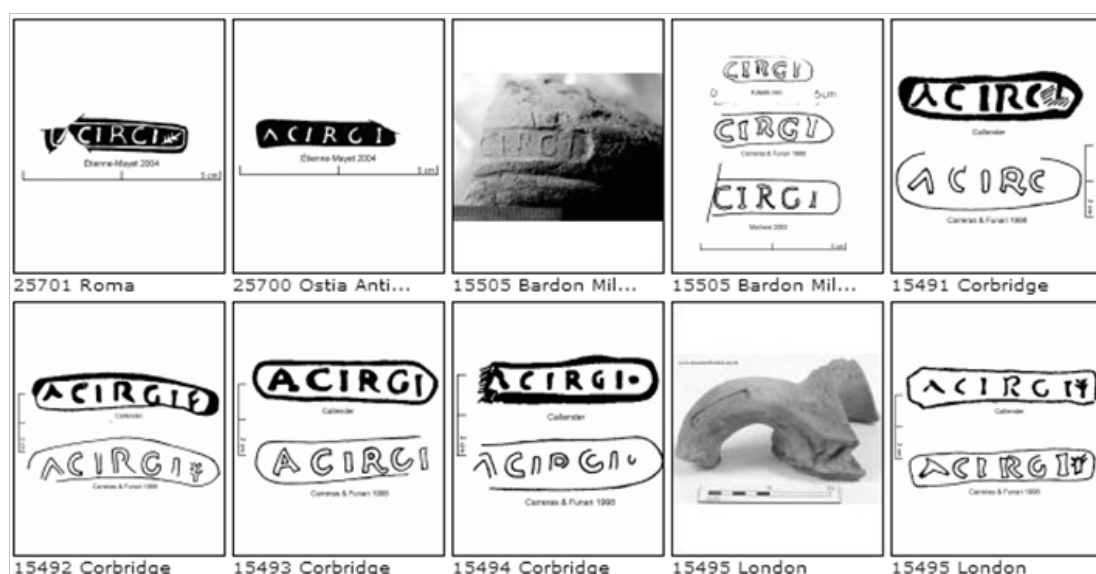


Fig. 2. Resultado de una pregunta acerca del sello ACIRGI en la base de datos CEIPAC.

**La economía del Imperio Romano: un debate todavía abierto.** Un aspecto crucial de cualquier sociedad es la producción, aprovisionamiento y redistribución de comida. Este tema ha sido, y sigue siendo, un problema abierto en el establecimiento de políticas de decisión sostenibles en una perspectiva de escala mundial. La distribución de comida durante el Imperio Romano se asocia comúnmente con el control del ejército. Se argumenta que el emperador y su círculo gestionaban la relación entre la comida y el ejército para así supervisar y controlar el territorio romano y fortalecer y mantener su poder político. Hay dos enfoques que son particularmente evidente en el debate actual sobre escalas y modalidades del sistema económico romano: (i) el sistema de comercio del Imperio Romano como un modelo específico sin relación con las economías globales modernas, y (ii) el sistema de comercio romano como predecesor de las economías globales modernas, perfectamente explicable mediante teorías económicas modernas. Ya sea asumiendo o no una analogía entre pasado y presente o viceversa, el debate científico se ha centrado más en la influencia de la capital del impe-

rio (Roma) en el control y la gestión del comercio a larga distancia, que no en el análisis del rol que tiene la distribución regional y periférica.

La arqueología romana resulta una fuente increíble de datos e información (ver Figura 1) sobre la producción y las transacciones económicas que se realizaban en el área de lo que es hoy la Europa moderna y la zona del Mediterráneo. Sin embargo, todavía no se ha realizado un estudio científico en profundidad de los mecanismos que han caracterizado estas conexiones políticas y económicas, fundamentalmente debido al escaso uso de enfoques y métodos formales en la investigación histórica, donde a menudo ni siquiera se considera la posibilidad de que esta investigación puede ser realizada y expresada usando lenguajes formales (codificados de manera no ambigua, y capaces de generar modelos que se pueden ejecutar por medio de métodos computacionales o analíticos). No obstante, las sociedades antiguas ofrecen una gran oportunidad para evaluar datos diacrónicos por medio de un laboratorio virtual en el cual se pueden construir modelos formales así como diferentes hipótesis y teorías sobre el pasado (ver Epstein 2008).

En este contexto, las tecnologías semánticas, como es el caso de OBDA, pueden tratar tanto datos discretos como influencias cualitativas para así responder a preguntas más amplias sobre los motivos y los patrones presentes en el registro histórico. En particular, nuestro sistema OBDA permite obtener información almacenada en la base de datos EPNet usando la terminología del dominio en cuestión, cosa que resulta más accesible a los investigadores (quienes son expertos en el dominio), y ofrece soporte a la identificación de patrones y tendencias presentes en esta información.

El uso del paradigma OBDA ayuda a EPNet a hacer frente al reto de ofrecer a los usuarios: (i) una tecnología para acceder a los datos de forma consistente con su propio dominio de información (véase el modelo conceptual de referencia y ontología introducidos en la siguiente sección), (ii) una plataforma preparada para integrar de manera semánticamente transparente nuevas fuentes de datos (conjuntos de datos históricos gestionados ya sea por laboratorios de investigación o organizaciones públicas), (iii) un mecanismo con fundamento teórico para homogeneizar información almacenada en distintos formatos y de acuerdo a distintas conceptualizaciones (por ejemplo, representaciones alternativas de periodos temporales, o localizaciones almacenadas con su nombre antiguo por un lado y su nombre moderno por otro).

Por medio de la tecnología OBDA, se pueden conectar distintos datos del conjunto EPNet para poder luego interpretarlos a distintos niveles y obtener así nuevo conocimiento sobre la complejidad de las relaciones comerciales en el Imperio Romano. Para poder generar este nuevo conocimiento y poder especificar valores y parámetros que puedan ser manipulados en experimentos y simulaciones, es esencial ir más allá de las limitaciones de las tradicionales bases de datos relacionales.

### 3. REPRESENTACIÓN DEL CONOCIMIENTO Y GESTIÓN DE DATOS EN EPNET

En esta sección se presenta el modelo conceptual de referencia (CRM) de EPNet, así como el modelo de datos (lógico) y la ontología que se derivan del mismo. Al final de la sección se introducen los conjuntos de datos de ‘Pleiades’ i ‘EDH’ (*Epigraphic Database Heidelberg*) cuyo contenido ha sido integrado en el conjunto de datos del proyecto, lo que resulta en (i) un aumento de aquella parte del dominio de conocimiento que queda cubierto por los datos que los usuarios finales tienen

disponibles (es decir, mayor completitud), y (ii) una mejora en la caracterización de las entidades geográficas ya presentes en el conjunto de datos inicial del proyecto (es decir, mayor precisión).

Para favorecer el mantenimiento del modelo, y de acuerdo con la naturaleza específica de las distintas piezas de información representadas, se ha estructurado el CRM en distintos módulos interrelacionados. Además, teniendo en cuenta el tema central de cada módulo, se han utilizado aquellas ontologías ya existentes y consideradas estándar en el campo de la web semántica. Éste es el caso de la ontología FaBiO (*FRBR-aligned Bibliographic Ontology*, <http://vocab.ox.ac.uk/fabio>), centrada en la representación de información de carácter bibliográfico.

**Principal.** Este módulo se encarga de representar las entidades principales del dominio (inscripciones, tipos anfóricos, información epigráfica, etc.), sus propiedades (lugar de hallazgo, transcripción, dimensiones, etc.) y relaciones (ver figura 3).

**Fig. 3. Fragmento del CRM de EPNet. Especifica cómo las inscripciones se relacionan con las actividades de producción, embasado y hallazgo. Muestra también que los sellos son inscripciones caracterizadas por, entre otros, relieve, forma y dirección de lectura. El modelo, escrito en ORM2, indica también que las inscripciones están conectadas con su transcripción, que puede**



**ser completa (*full*) o en versión simplificada (*simplified*), proporcionando información sobre su estado de conservación o su traducción a lenguajes modernos, respectivamente.**

**Tiempo.** Ofrece una conceptualización de las distintas modalidades de representación de intervalos, periodos, fechas y instantes puntuales de tiempo con respecto al dominio de investigación. Tal y como se explica en la sección 4.1, los distintos formatos que los expertos utilizan para tratar la información temporal son homogeneizados por el sistema OBDA, manteniendo la flexibilidad epistemológica que proporcionan al buscar datos específicos y, al mismo tiempo, permitiendo el intercambio de datos en los distintos formatos así como la traducción de un formato a otro (por ejemplo, traducir el texto 'Trajan Government' a su correspondiente rango de años '98-117').

**Espacio.** Se centra en representar la información concerniente a la localización geográfica de las entidades descritas en el módulo Principal del CRM. Esta información va desde la actividad de hallazgo de un objeto hasta la posición relativa de una inscripción respecto a otros elementos estructurales o estilísticos del ánfora. Por este motivo se ha dividido el módulo en dos: (i) uno centrado en el objeto epigráfico, donde se representan las relaciones espaciales entre los elementos estructurales y epigráficos del ánfora, y (ii) uno geográfico, donde se representa la localización del objeto en su momento de hallazgo, producción, etc., incluyendo las coordenadas de latitud y longitud que sitúan dicha localización en un mapa, así como la función de la localización (campamento militar, asentamiento civil, etc.). Este módulo geográfico, complementado con información integrada desde otras fuentes (véase final de esta sección), ofrece la posibilidad de geo localizar las entidades del dominio así como hacer una distinción y establecer una correlación semánticamente sólida entre lugares históricos (por ejemplo, las provincias romanas) y lugares modernos.

**Documental.** Este módulo se dedica a la representación de la información bibliográfica que documenta las entidades del dominio. Esta información puede hacer referencia a artículos de congresos, revistas, libros, portales web, enciclopedias digitales, etc.

**Tipología.** Es una colección de todas las estructuras taxonómicas que caracterizan a las entidades del módulo Principal del CRM. El tener todas estas taxonomías en un único lugar hace que su mantenimiento y sucesivas extensiones sean mucho más sencillas, también para los investigadores sin formación técnica.

Este CRM con sus cinco módulos, además de ser formalmente correcto y consistente, abarca lo bastante como para permitir representar toda la información y conocimiento que los expertos tienen sobre el dominio en cuestión, siendo una mejora significativa en calidad y granularidad con respecto a las descripciones informales de los datos de que disponíamos al inicio del proyecto EPNet.

**Conjunto de datos EPNet.** Aún cuando el CRM representa el conocimiento del dominio, no especifica cómo se almacenan realmente los datos. Este almacenamiento depende en gran medida de la tecnología subyacente, motivo por el cual es práctica común especificar el almacenamiento y el conocimiento del dominio por separado.

En EPNet se usa un sistema gestor de bases de datos relacional (SGBDR) para almacenar los datos. Por este motivo se ha realizado una especificación relacional que complementa a nuestro CRM. Un SGBDR estructura los datos en forma de tablas (también llamadas relaciones), así pues una especificación relacional indica cuáles son las tablas que forman la base de datos y cuáles son sus atributos (columnas). Es importante destacar que los datos disponibles actualmente en el proyecto

no cubren el conocimiento representado en el CRM en su totalidad sino solamente un subconjunto. En consecuencia, los esfuerzos en proporcionar una especificación relacional para el proyecto se han centrado en este subconjunto en particular. La figura 4 muestra un pequeño fragmento (debido a razones de espacio) de esta especificación relacional. Las tablas se muestran como cajas, con su nombre en la parte superior (por ejemplo, *Inscription*) y la lista de atributos a continuación (por ejemplo, *id*, *carrier*). Cada atributo consiste en un nombre y un tipo de datos (por ejemplo, *id* INT(11)), lo cual indica que el identificador de una inscripción es un número entero). En particular, préstese especial atención a las tablas *informationcarrier*, *amphoratype* y *amphotyping*, las cuales usaremos en los ejemplos de la siguiente sección. La tabla *informationcarrier* almacena datos sobre ánforas, tales como el número de inventario y referencias a sus actividades de producción y hallazgo (los datos referentes a estas actividades se almacenan en tablas separadas). La tabla *amphoratype* almacena los tipos anfóricos, mientras que *amphotyping* establece la correlación entre los números de inventario de la ánforas y el tipo anfórico correspondiente (puede ser más de uno en caso que el tipo exacto no hayo podido ser determinado con precisión). Las relaciones entre las tablas se muestran en la especificación como líneas que las conectan (véase por ejemplo las líneas conectando *informationcarrier*, *amphotyping* y *amphoratype*).

Ontología EPNet. A partir del CRM y la especificación relacional discutidos previamente se ha generado una ontología. Ésta es un elemento imprescindible para permitir a los usuarios el acceso conceptualizado a los datos usando la terminología propia del dominio. La ontología resultante, que está escrita en un lenguaje formal cuya expresividad permanece dentro del perfil estándar OWL2 QL<sup>14</sup>, captura el conocimiento del dominio al mismo tiempo que tiene en cuenta los datos y los requisitos de los usuarios en términos de accesibilidad y uso. Así pues, modifica y extiende el vocabulario de la base de datos (mediante jerarquías de conceptos; véase ejemplo 4.2), reintroduciendo parte de la terminología del dominio usada por los expertos.

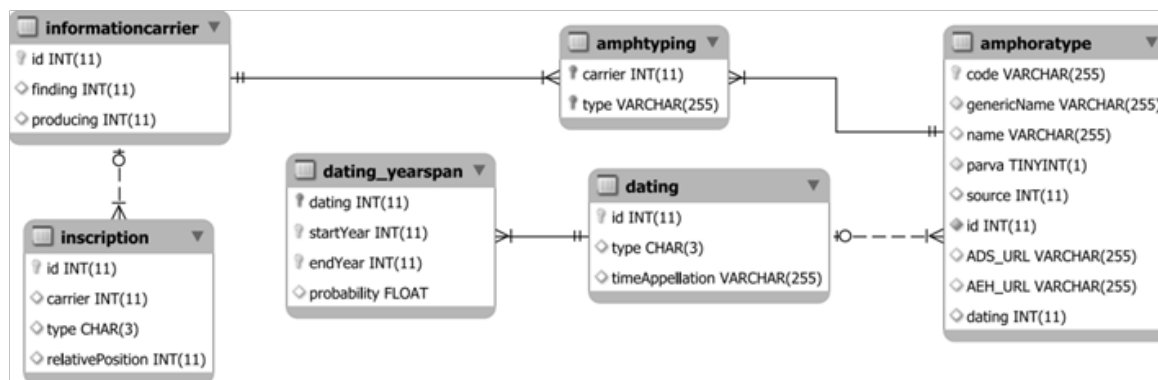


Fig. 4. Un fragmento de la especificación relacional de nuestra base de datos.

La mayoría de proyectos que se desarrollan actualmente en el campo de la herencia cultural y que tratan con tecnologías semánticas pretenden que la conceptualización del dominio exponga los datos de forma que sean comprensibles a una audiencia muy amplia (desde turistas que visitan un museo o buscan en la web su obra de arte favorita, hasta administraciones publicas que quieren abrir al público sus recursos culturales y propiedades históricas). En contraposición con este enfoque, la ontología EPNet ha sido especificada en colaboración con expertos en la historia del Imperio Romano con el objetivo principal de: (i) ofrecerles soporte para medir los cambios agregados que se su-

<sup>14</sup> <http://www.w3.org/TR/owl2-profiles/>

ceden a lo largo de décadas y siglos, (ii) probar hipótesis históricas a lo largo de una escala temporal de siglos, y (iii) recoger de forma sistemática información que permita discutir las argumentaciones consideradas como estándar (Guldi y Armitage 2014). La característica principal de la ontología EPNet, así como del conocimiento recogido en el CRM, es el de estar orientado a la investigación. La ontología contiene así un conjunto de axiomas que proporcionan definiciones formales para los conceptos y relaciones que los expertos utilizan cuando clasifican conceptualmente las entidades de su dominio de investigación. Como ejemplo<sup>15</sup>, considérese los siguientes axiomas:

```
:Stamp rdfs:subClassOf :Inscription .
:TitulusPictus rdfs:subClassOf :Inscription .
:Amphora rdfs:subClassOf :InfCarrier .
:carriedBy rdfs:domain :Inscription .
:carriedBy rdfs:range :InfCarrier .
:producedAt rdfs:domain :InfCarrier .
:producedAt rdfs:range :TimeSpan .
:hasName rdf:type owl:DatatypeProperty .
```

Éstos indican que los conceptos `:Stamp` y `:TitulusPictus` son ambos casos particulares (`rdfs:subClassOf`) del concepto `:Inscription` (véase también la figura 3), mientras que `:Amphora` lo es de `:InfCarrier`. la relación `:carriedBy` conecta inscripciones con su correspondiente objeto epigráfico. De manera similar, el dominio y el rango de la relación `:producedAt` se definen como el concepto `:InfCarrier` por un lado y el concepto `:TimeSpan`, denotando el periodo de tiempo dentro del cual la producción del objeto tuvo lugar, por otro. El último axioma caracteriza la propiedad `:hasName`, cuyo rango es un tipo de datos (en este caso será `xsd:string`).

Adicionalmente, para ofrecer al usuario un vocabulario centrado más completo, se han añadido algunos axiomas especiales, como por ejemplo, el siguiente axioma que introduce una nueva relación `:engravedOn` en la ontología, la cual se define como una generalización de la ya mencionada `:carriedBy`.

```
carriedBy rdfs:subObjectPropertyOf :engravedOn .
```

Nótese que la expresividad de OWL2 QL permite la especificación, entre otras, de restricciones de disyunción entre conceptos, lo cual a su vez ofrece la posibilidad de realizar comprobaciones de consistencia de los datos mediante la aplicaciones de técnicas de razonamiento convencionales (véase sección 4.2). La realización de estas comprobaciones de consistencia es particularmente interesante en este contexto, dado que los datos son normalmente introducidos de manera manual por usuarios no expertos y sin el soporte de ningún tipo de interfaz de entrada de datos.

**Pleiades**<sup>16</sup>. Es un diccionario geográfico de acceso abierto sobre lugares del mundo antiguo. Proporciona URIs (*Uniform Resource Identifiers*) estables que identifican a decenas de miles de entidades geográficas. Construido en base al proyecto *Classical Atlas* (1988-2000) el cual dio lugar al *Barrington Atlas of the Greek and Roman World* (Talbert 2000), Pleiades está coorganizado por el

<sup>15</sup> Una imagen más completa de la ontología está disponibles en <http://136.243.8.213/epnet-pleiades-edh/> donde se ha implementado una interfaz web simple destinada a testear el sistema OBDA y su capacidad de responder preguntas.

<sup>16</sup> <http://pleiades.stoa.org>

*Institute for the Study of the Ancient World* (NYU) y el *Ancient World Mapping Center* (UNC Chapel Hill), y está empezando a expandirse más allá de sus orígenes greco-romanos al mismo tiempo que está estableciendo líneas de interoperabilidad con varios otros recursos web que tratan los elementos geográficos, textuales, visuales y físicos de las culturas de la antigüedad. Pleiades complementa el conjunto de datos de EPN<sub>ET</sub> en tanto que, por un lado ofrece un número estrictamente mayor de entidades geográficas, y por otro ofrece una mayor precisión que será útil a la hora de trazar rutas comerciales y establecer conexiones de carácter económico entre distintas partes del territorio del Imperio Romano. En este último sentido, el de ofrecer una mayor precisión, el uso de Pleiades permite obtener las coordenadas geográficas de aquellas localizaciones que en los datos de EPN<sub>ET</sub> no están geo localizadas.

**EDH.** La *Epigraphic Database Heidelberg*<sup>17</sup> es un miembro fundador del *Electronic Archive of Ancient Greek and Latin Epigraphy* (EAGLE) y de la *Europeana Best Practice Network for Ancient Greek and Latin Epigraphy* (EAGLE BPN). La responsabilidad principal de EDH como archivo epigráfico del consorcio EAGLE es coleccionar todas las inscripciones latinas y bilingües (griego y latín) de las provincias del Imperio Romano. Esto se consigue mediante el desarrollo y mantenimiento de cuatro bases de datos: una para transcripciones, una para fotos de inscripciones<sup>18</sup>, una base bibliográfica para todas las publicaciones citadas en las inscripciones<sup>19</sup>, y una base geográfica. EDH almacena datos provenientes del *Année Épigraphique*<sup>20</sup> y comprueba todas las lecturas de las inscripciones, proporcionando no solo una reproducción del texto publicado pero también una nueva edición del mismo siguiendo una codificación estándar. También proporciona un detallado conjunto de información, bien estructurado, junto con metadatos relativos al soporte de la inscripción, su texto, tipología, contenido y temática. Permite realizar búsquedas complejas a través de más de 70.000 registros, devolviendo al usuario una información rica, acompañada de fotos cuando están disponibles así como enlaces a traducciones cuando estas están presentes en el EAGLE MediaWiki<sup>21</sup>.

En el contexto del proyecto EAGLE BPN, EDH lidera el esfuerzo de enlace, armonización y curación de contenido, con el objetivo de proporcionar un conjunto de datos que pueda ser incorporado en Europeana<sup>22</sup>. En particular, EDH utiliza una versión simplificada del lenguaje TEI/EpiDoc para codificar los datos acerca de las inscripciones.

#### 4. OBDA EN EPN<sub>ET</sub>

Desde mediados de los 2000, el enfoque *Ontology-Based Data Access* (OBDA) se ha popularizado como medio para tratar los problemas mencionados en la sección 2. La arquitectura del sistema OBDA implementado en EPN<sub>ET</sub> se muestra en la figura 5. En dicha arquitectura, la ontología presentada en la sección 3 constituye la capa conceptual, la cual modela el dominio, define el vocabulario compartido, oculta la estructura de las bases de datos subyacentes y permite enriquecer datos incompletos gracias al uso del conocimiento del dominio. Las preguntas se formulan por parte de los usuarios sobre esta capa conceptual, de tal modo que no es necesario conocer la estructura interna de las bases de datos, su relación, o las distintas codificaciones de los datos.

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<sup>17</sup> <http://edh-www.adw.uni-heidelberg.de/>

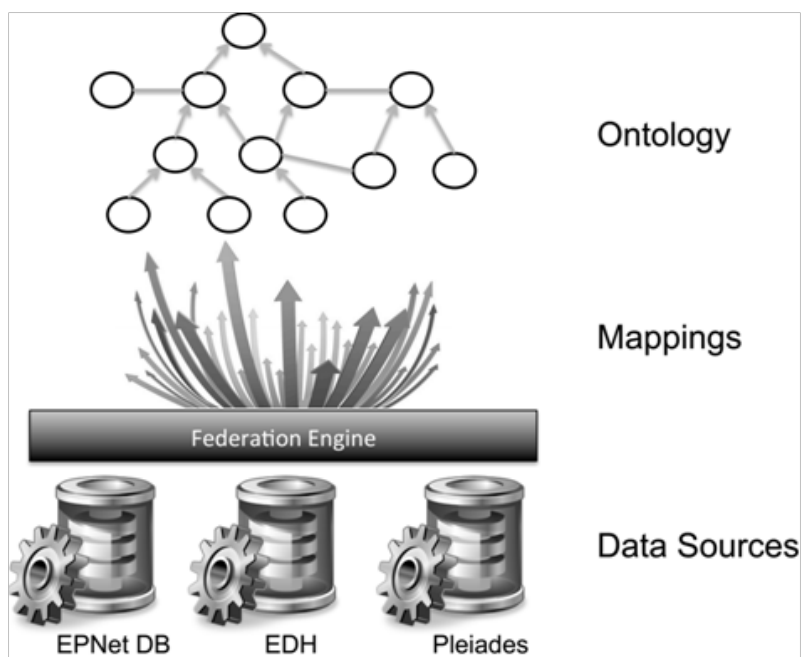
<sup>18</sup> <http://edh-www.adw.uni-heidelberg.de/foto/suche/>

<sup>19</sup> <http://edh-www.adw.uni-heidelberg.de/bibliographie/suche/>

<sup>20</sup> <http://www.anneeepigraphique.msh-paris.fr/>

<sup>21</sup> <http://www.eagle-network.eu/wiki/>

<sup>22</sup> <http://www.europeana.eu/portal/>



**Fig. 5. Arquitectura del sistema OBDA de EPNet.**

El sistema OBDA traduce una pregunta escritas en términos de la ontología en un conjunto de preguntas dirigidas a las distintas bases de datos integradas en el sistema. Esta traducción se puede realizar gracias a la existencias de un *mapping*, una especificación declarativa de la relación existente entre los elementos definidos en la ontología (conceptos y propiedades) y la estructura relacional de cada una de las bases de datos subyacentes. Intuitivamente se puede decir que el mapping expone los datos almacenados en las distintas bases como si formaran parte de un único repositorio virtual en formato RDF (*Resource Description Framework*). Este formato es un estándar definido por el *World Wide Web Consortium* (W3C) para representar datos con el objetivo de su intercambio en la web, y se basa en la idea de formular sentencias en la forma “sujeto-predicado-objeto” referidas a recursos. Estas sentencias se denominan triplas en la terminología RDF. Algunos ejemplos son los siguientes:

```
http://epnet-url.org/1 rdf:type :Amphora
http://epnet-url.org/1 :producedIn http://epnet-url.org/place/5
```

donde se establece que el elemento representado por el URI `http://epnet-url.org/1` es un ánfora, y que fue producido en el lugar identificado por el URI `http://epnet-url.org/place/5`. Intuitivamente, cada una de las expresiones que forman el mapping consiste de una parte llamada *target*, en la que se define una tripla, en la forma anteriormente mencionada, que será producida por esta expresión en particular, y otra parte llamada *source*, donde se indica en el lenguaje SQL usado por las bases de datos relacionales cómo se extraen los datos de estas bases para construir con ellos la tripla indicada en el *target*. Las expresiones del mapping tienen pues la siguiente forma:

$$\underbrace{(\text{sujeto predicado objeto})}_{\text{tripla } \textit{target}} \leftarrow \underbrace{\text{pregunta SQL}}_{\text{pregunta } \textit{source}}$$



Los sujetos y objetos presentes en las triplas RDF son recursos (individuos o valores) representados por URIs o literales, respectivamente, los cuales son generados por las distintas expresiones presentes en el mapping. Como ejemplo, la plantilla `:Amphora-{ic_id}`, donde `ic_id` es un atributo de alguna tabla de las bases de datos, genera el URI `:Amphora-1` cuando `ic_id` es instanciado con el valor `'1'`. El símbolo ``:'` representa el prefijo por defecto a ser usado en los URIs, el cual, en este ejemplo, es `http://epnet-url.org`, de tal modo que el URI completo generado es `http://epnet-url.org/Amphora-1`.

**Ejemplo 4.1 (EPNet mapping).** El mapping siguiente se encarga de poblar con datos el concepto `:Dressell` de la ontología (el cual es un subtipo del concepto `:Amphora`):

```
:Amphora-{ic_id} rdf:type :Dressell
←
SELECT ic.id AS ic_id, t.code AS t_code
FROM InformationCarrier ic
JOIN AmphTyping amt ON amt.carrier=ic.id
JOIN AmphoraType t ON t.code=amt.type
WHERE amt.type='DR1'
```

Como se puede observar, la pregunta SQL presente en este mapping es bastante compleja, ya que incluye múltiples operaciones de *join* y hace uso de la codificación interna del tipo Dressell 1 mediante el código DR1. Esta complejidad queda oculta a los usuarios por medio del concepto `:Dressell`.

La ontología, junto con el mapping y las bases de datos subyacentes expone un repositorio RDF virtual sobre el que se pueden hacer preguntas usando el lenguaje SPARQL, el cual es el lenguaje estándar de consulta en la comunidad de la Web Semántica.

**Ejemplo 4.2.** Supóngase que un usuario quiere obtener todas las ánforas producidas en “La Corregidora” y quiere ver también sus correspondientes coordenadas. Esta pregunta se puede expresar en SPARQL usando el vocabulario de la ontología:

```
SELECT ?amph ?lat ?lng
WHERE {
  ?amph rdf:type :Amphora .
  ?amph :producedIn ?ppl .
  ?ppl rdf:type :Place .
  ?ppl :hasName "La Corregidora" .
  ?amph :foundIn ?fpl .
  ?fpl rdf:type :Place .
  ?fpl :hasLatitude ?lat .
  ?fpl :hasLongitude ?lng .
}
```

Obsérvese que los usuarios no tienen que conocer los códigos que identifican los tipos anfóricos, ni tampoco tienen que combinar manualmente los resultados provenientes de las tres bases de datos (EPNet y EDH para los objetos anfóricos, y Pleiades para las coordenadas).

Existen varios sistemas OBDA desarrollados tanto en la academia como en la industria (Rodríguez-Muro y Rezk 2015; Bisho et al. 2011; Sequeda, Arenas y Miranker 2014; Civili et al. 2015). En nuestro proyecto trabajamos con el Ontop (Rodríguez-Muro y Rezk 2015; Xiao et al. 2014; Kontchakov et al. 2014; Calvanese et al. 2015) un sistema ya maduro y de código abierto, el cual se está usando actualmente en numerosos proyectos. Ontop permite a los usuarios materializar repositorios RDF virtuales de tal modo que puedan ser usados en conjunción con *triplestores* (bases de datos que siguen el modelo RDF en lugar del relacional) o, de manera alternativa, mantener dichos repositorios como virtuales, redirigiendo las preguntas de los usuarios a las bases de datos relacionales subyacentes. Este segundo enfoque, el llamado enfoque virtual, evita el coste de tener que materializar los datos (hacer una copia de los datos relacionales pasándolos a formato RDF) y además permite beneficiarse de los más de 30 años de madurez de los sistemas de bases de datos relacionales, lo cual implica disponer de una ejecución eficiente de preguntas, seguridad de los datos, la posibilidad de realizar transacciones (conjuntos de instrucciones que se ejecutan de forma atómica, es decir, o se ejecutan todas o no se ejecuta ninguna, y sin sufrir interferencias por parte de otras instrucciones que puedan estar ejecutándose simultáneamente en la base de datos, etc.). Para poder responder las preguntas formuladas por los usuarios en el lenguaje SPARQL, Ontop reescribe estas preguntas a lenguaje SQL haciendo uso de la relación existente entre la ontología y las bases de datos definida en el mapping. Para ilustrar este punto, volvamos al ejemplo 4.2. Cuando el usuario pregunta por el concepto `:Amphora`, Ontop usa la ontología para inferir que todos los elementos que pertenecen a alguno de sus subtipos (por ejemplo, `:Dressell`) también pertenecen a `:Amphora`. Intuitivamente, Ontop reescribe la pregunta del ejemplo 4.2 creando una unión por cada subtipo de `:Amphora`:

```
SELECT ?amph ?lat ?lng
WHERE {{
  ?amph rdf:type :Amphora .
  ?amph :producedIn ?ppl .
  ?ppl :hasName "La Corregidora".
  ?amph :foundIn ?fpl .
  ?fpl :hasLatitude ?lat.
  ?fpl :hasLongitude ?lng .
} UNION {
  ?amph rdf:type :Dressell .
  ?amph :producedIn ?ppl .
  ?ppl :hasName "La Corregidora".
  ?amph :foundIn ?fpl .
  ?fpl :hasLatitude ?lat.
  ?fpl :hasLongitude ?lng .
} UNION {
  ?amph rdf:type :Leptiminus1 .
  .
}}
```

Ontop está disponible como *plug-in* de la herramienta Protégé, como SPARQL *endpoint* usando el *framework* Sesame, y como librería de Java compatible con OWL API.

#### 4.1. Integración de datos en EPNet

Ontop permite llevar a cabo una integración virtual de datos, enfoque en el cual los datos permanecen en sus fuentes originales donde son accedidos cada vez que se formula una pregunta. Ontop

no modifica pues las bases de datos siendo integradas, lo cual es un requisito en este caso de uso, ni tampoco requiere de procesos complejos de extracción, transformación y carga de datos (ETL). Los conceptos y propiedades de la ontología agrupan diferentes fragmentos de las bases de datos en conjuntos de triplas homogéneos y bien definidos.

Ontop no trata directamente el tema de la distribución de los datos, para ello delega en alguno de los sistemas de federación de bases de datos ya existentes como es el caso de Teiid<sup>23</sup> o Exareme (Killapi et al. 2015). Cualquiera de estas federaciones crea la ilusión de que un conjunto dado de distintas bases de datos, las cuales pueden estar instaladas en distintas máquinas, formaran parte de una única base instalada en una única máquina, es decir, resuelven el problema de tener que tratar con datos distribuidos entre distintas bases.

Para ilustrar la integración llevada a cabo por Ontop, discutiremos el caso de la integración de los datos de EPNet y Pleiades centrándonos en los datos relativos a información espacial y periodos temporales. La integración empieza en la ontología, donde los conceptos cubren información proveniente de los dos conjuntos de datos. El concepto `:Place`, por ejemplo, se caracteriza en la ontología por tener una determinada función (por ejemplo, `:ProductionPlace`, `:CivilSettlement`, etc.), y está conectado con sus geo-coordenadas a través de las propiedades `:hasLatitude` y `:hasLongitude`. De manera similar, una cierta instancia de `:Place` está conectado vía la propiedad `:fallsWithin` con otras instancias de `:Place`. La información de ambos conjuntos de datos se conecta a través de propiedades, en este caso:

- `:producedIn` conecta ánforas en EPNet con lugares en EPNet y en Pleiades
- `:hasLatitude` y `:hasLongitude` conectan lugares en EPNet y Pleiades con coordenadas geográficas en ambos conjuntos de datos.

**Espacio.** Tanto EPNet como Pleiades incluyen información relativa a lugares, sin embargo Pleiades es más completo en tanto que se especializa en este tema. Si un lugar no aparece registrado en los datos de EPNet, nuestro sistema integrado usa los datos de Pleiades. Si el lugar existe en EPNet pero las coordenadas no están disponibles, el sistema completa la información de EPNet con las coordenadas de Pleiades. Si el lugar existe en EPNet junto con sus coordenadas, todavía es útil disponer de Pleiades ya que este nos proporciona información sobre el tipo de asentamiento (civil, militar, etc.), datos que no están disponibles en EPNet. Para realizar esta integración necesitamos disponer de un único concepto bien definido, `:Place`, que ya hemos mencionado con anterioridad, y el mapping correspondiente. A continuación se muestra una versión simplificada del mapping:

Caso Pleiades:

```
pleiades:{path} rdf:type :Place
←
SELECT pp.path AS path
FROM pleiades.places pp
JOIN pleiades.names pn ON pn.pid=pp.id
```

Caso EPNet:

---

<sup>23</sup> <http://teiid.jboss.org/>

```

:Place-{gl_id} rdf:type :Place
←
SELECT gl.id AS gl_id
FROM GeographicLocation gl

```

Obsérvese que los URIs en el mapping incluyen información de la procedencia de los datos en sus prefijos, es decir, “pleiades:” y “:” (EPNet es el prefijo por defecto). Esto puede ser útil a los usuarios ya que saben en todo momento cuál es la fuente de la información.

**Tiempo.** Con relación a los periodos temporales, EPNet y Pleiades los especifican usando listas de enteros. Por ejemplo, [(98; 117); (130; 140)] indica que un cierto objeto o lugar existió en el periodo 98 d.C. – 117 d.C. o en el periodo 130 d.C. – 140 d.C. Además de estos valores numéricos, los usuarios están a menudo interesados en utilizar periodos de tiempo predefinidos, tales como las épocas en que gobernaron ciertos emperadores. Por ejemplo, en lugar de utilizar 98 d.C. – 117 d.C., se pueden referir a este periodo temporal como :Trajan-Government. El siguiente mapping define este término:

```

:Amphora-{ic_id} :producedAt :Trajan-Government
←
SELECT ic.id AS ic_id
FROM hcomplex join i
WHERE startYear <= 117 AND endYear >= 98

```

Los usuarios pueden preguntar pues por las ánforas producidas durante este intervalo de tiempo mediante las siguientes dos preguntas equivalentes:

```

SELECT ?amph
WHERE {
  ?amph rdf:type :Amphora .
  ?amph :producedAt :Trajan-Government .
}

SELECT ?amph
WHERE {
  ?amph rdf:type :Amphora .
  ?amph :producedAt ?ptime .
  ?ptime rdf:type :YearSpan.
  ?ptime :startsAt ?sy.
  ?ptime :endsAt ?ey.
  FILTER (?sy <= 117 && ?ey >= 98)
}

```

## 4.2 Consistencia de datos con Ontop

Un lenguaje ontológico basado en la lógica, como es el caso del lenguaje OWL, permite especificar ontologías como teorías lógicas, lo cual implica que es posible restringir las relaciones entre conceptos, propiedades y datos. En el enfoque OBDA, pueden aparecer inconsistencias si sucede que los datos en las fuentes combinados con los mappings no satisfacen alguna de las restricciones definidas en la ontología. Es importante pues comprobar cuando ocurren estas inconsistencias. A

continuación se describen algunos de los tipos de restricciones más importantes y que pueden dar lugar a la aparición de inconsistencias:

- **Disyunción.** Indica que la intersección entre dos conceptos o propiedades tiene que ser vacía. Por ejemplo, los conceptos `:MilitaryCamp` y `:CivilSettlement` deben ser disjuntos.
- **Propiedades funcionales.** Un individuo no puede estar conectado por medio de una propiedad funcional con más de un elemento. Por ejemplo, la propiedad `:hasShape` es funcional porque un sello tienen una sola forma.

Nótese que mientras que las restricciones de disyunción se pueden expresar en OWL2 QL, las de funcionalidad no. Sin embargo, ambos tipos de restricciones pueden ser comprobadas por Ontop mediante la formulación de preguntas adecuadas y la comprobación de si la respuesta a estas preguntas es o no vacía.

## 5. INTERFAZ DE USUARIO

Una interfaz de usuario de carácter preliminar está disponible online<sup>24</sup> con el objetivo de testear las funcionalidades OBDA del sistema. Ofrece a los usuarios un área de texto donde pueden escribir preguntas en el lenguaje SPARQL, usando el vocabulario de la ontología discutida en la sección 3 (para la conveniencia del usuario, la interfaz ofrece un resumen de la ontología; véase la figura 6). Después de ejecutar una pregunta, la interfaz muestra el texto de la misma en el lenguaje SQL, siendo esta la consulta que realmente se ha ejecutado en la base de datos subyacente (ver figura 7), así como muestra también la respuesta a la pregunta en formato tabular (figura 8).

The screenshot displays the OBDA system web interface. At the top, there is a text area labeled "SPARQL query:" containing the following query:

```
PREFIX : <http://136.243.8.213/obdasystem#>
PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
SELECT * WHERE {
  ?x rdf:type :Amphora .
  ?x :producedIn ?pl .
  ?pl rdf:type :Place .
  ?pl :hasName "La Corregidora" .
  ?pl :hasLatitude ?lat .
  ?pl :hasLongitude ?long
}
```

Below the query area is a button labeled "Execute". Underneath the button is a section titled "Ontology". This section contains the prefix "Prefix: http://136.243.8.213/obdasystem#" and a list of classes under the heading "Classes:". The classes are listed in a hierarchical tree structure:

- Thing
  - Alphabet
  - AmphoraSection
  - AmphoricType
  - DatingTechniques

Fig. 6. Interfaz web del sistema OBDA donde se muestra una pregunta introducida por el usuario.

<sup>24</sup> <http://136.243.8.213/epnet-pleiades-edh/>



SQL query
<pre> SELECT ... FROM InformationCarrier QVIEW1, Producing QVIEW2, Activity_Location QVIEW3, ProductionPlace QVIEW4, GeographicLocation QVIEW5 WHERE QVIEW1."id" IS NOT NULL AND (QVIEW1."producing" = QVIEW2."id") AND (QVIEW1."producing" = QVIEW3."activity") AND (QVIEW3."location" = QVIEW4."id") AND QVIEW3."location" IS NOT NULL AND </pre>

**Fig. 7. La pregunta del usuario reescrita en el lenguaje SQL para su ejecución contra la base de datos.**

Query result (only first 50 rows shown):

<http://136.243.8.213/obdasystem#Amphora-34389>	<http://136.243.8.213/obdasystem#Place-28519>
<http://136.243.8.213/obdasystem#Amphora-34388>	<http://136.243.8.213/obdasystem#Place-28519>
<http://136.243.8.213/obdasystem#Amphora-29223>	<http://136.243.8.213/obdasystem#Place-28519>

**Fig. 8. Respuesta a la pregunta del usuario.**

## 6. PREGUNTAS HISTÓRICAS

En esta sección se ejemplifica la utilidad del sistema OBDA como herramienta para resolver preguntas de carácter histórico en el contexto del proyecto EPNet. Para ello se describen a continuación cuatro preguntas cuyo estudio resulta interesante. También discutimos algunos resultados preliminares para algunas de ellas.

### 6.1 Pregunta A (*Agatephori*)

Buscamos tituli beta del conventus de *Astigi* que mencionen a un personaje de nombre *Agatephori*. Queremos obtener tanto la transcripción como la datación. El resultado incluye, entre otros, los siguientes tituli:

214: R Astigis arca [p(ondo) ---] / actus **Agathephori** et **M[emmia(ni)]** p(ensit?) / **Res[ti]tutus** Sabino et Apoll[inare cos]  
214: [R Astig(is) arc]a p(ondo) CCLIII [---] / [actus **Agathep]hori** et **Eutychi[---]** / [Sabino] et Apollina[re cos]  
218: [R Astigi]s arc(a) p(ondo) CC[---]III / [act(us) **Agathe]phori** et **Mem(miani)]** p(ensit?) / **Ati[metio]** / [Imp(eratore) Sever(o) M]acrino A[u]g(usto) et Adven[to cos]  
219: [R] Astig(is) arca [p(ondo) ---] / [a]ctus **Agathephori** et **M[em(miani)]** p(ensit?) **Atimetio?** / [Aure]lio Domino N(ostro) II et Sacer[dote II cos]  
221: [R] Astigis arca p(endo) eccli[---] / [actus] **Agatepori** et **Eut[---]** p(ensit) [---] / Grato et [Seleuco cos]  
224: [R] Astig(is) arca p(endo) ccl[---] / [actus] **Agatepori** et **Eut[iches]** p(ensit) / [sec]undu(s) Iuliano ii et Crispin[o cos]

224: [R Asti]g(is) arca p(endo) ccxl[---] / [actus **Agath**ep(h)ori et **Eutiches** [p(ensit)] / [**resti**]tutus Iuliano ii et Cri[spino cos]

228: R [Astig(is)] arca p(ondo) --- / act(us) **A[ga]thephor[i]** p(ensit?) **A[time]tio** / Modesto II et Probo [cos]

Estos nos muestran que *Agatephori* estuvo activo, como mínimo, entre los años 214 y 228 d.C., y trabajó con otros dos personajes de nombre *Memmiani* y *Eutiches*. En concreto:

- *Agatephori* trabajó con *Memmiani* en los años 214, 218 y 219 d.C.
- *Agatephori* trabajó con *Eutiches* en los años 214, 221 y 224 d.C.

También vemos que se mencionan otros tres personajes, de nombre *Restitut*us, *Atimetio* y *Secundus*, que trabajaron en conjunción con los pares *Agatephori et Memmiani* y *Agatephori et Eutiches*.

- *Restitut*us trabajó con *Agatephori et Memmiani* en el año 214 d.C.
- *Restitut*us trabajó con *Agatephori et Eutiches* en el año 224 d.C.
- *Atimetio* trabajó con *Agatephori* en los años 216, 217, 220, 223 y 224 d.C.
- *Atimetio* trabajó con *Agatephori et Memmiani* en los años 218 y 219 d.C.
- *Secundus* trabajó con *Agatephori* en los años 216, 220 y 224 d.C.
- *Secundus* trabajó con *Agatephori et Eutiches* en el año 224 d.C.

## 6.2 Pregunta B (*comparante*)

Partimos de una inscripción ya conocida, registrada en la base de datos de Heidelberg con el número HD032585:

-----] / [--- proc(uratori)] / monetae subpraef(ecto) ann[onae] / proc(uratori) ad **olea comparand(a)**  
p[er re]gionem Tripolit(anam) proc(uratori) al[imen]/[t]orum per reg(iones) Umbriam atq(ue)  
Picen(um) / praef(ecto) alae Aprianae tr(ibuno) coh(ortis) eq(uitatae) sagi<t>(ariorum) // XIII  
Kal(endas) Mar(tias) deposs(i)o / Baleri(a)e(!) Iustin(a)e vene(!) / merenti qu(a)e bixit(!) annos  
XXXX

Referencias:

CIL 06, 41295; fig. α u. β.

A. Ferrua, RAL 28, 1973, 68 s. n. 11; tav. 3, 1a u. b. (B) - AE 1976.

ICUR n. s. 14678.

AE 1973, 0076.

Datación: 231 AD – 400 AD

Queremos ver información referida a alguna acción que pueda ponerse en relación con los datos de que disponemos sobre la acción de “comparatio”. Para ello buscamos inscripciones que contengan el término “comparan” o “conparan”.

Encontramos tituli picti provenientes del corpus del CEIPAC así como inscripciones monumentales provenientes de la base de Heidelberg. Los tres tituli picti son relevantes para nuestro estudio:

- 227: R Cord(---) [-----] / **[c]omparante** Te[--- -----?] / p(---) Felicio Albino e[t Maximo cos]
- 229: [R co]rd p cccxii / **[compar]ante** dionysio aug [l] / [acc h]ermes imp alexandro/ [aug] iii et ca[s]sio dione co[s]
- sin datación: R cordu[--- / **[compa]rante** cerd[one ---] / [---]

De las inscripciones de Heidelberg, una es la que nos servía de punto de partida (HD032585), pero las otras no son relevantes para nuestro caso.

La *comparatio*, compra por parte del estado de algún producto en caso de necesidad, es, normalmente, una situación particular de la que tenemos noticias referidas a la compra de grano, pero estas son las únicas noticias que tenemos referidas al aceite.

La documentación conocida hasta ahora muestra que los tres tituli picti proceden de la zona fiscal del conventus *cordubensis*. Dos de estos tituli pueden ser datados, uno en 227 y otro en 229 d.C., lo que nos lleva a preguntar si se trataba de una acción puntual referida a estos dos años o si se corresponde con un cambio en el sistema de organización del control del aceite bético y africano. Otra línea de estudio que este resultado nos sugiere es si el hallazgo sólo en el distrito fiscal de Corduba es un hecho casual o hay una razón particular que lo explica.

En el único caso en el que encontramos el titulus delta completo aparece como comparante el personaje Dionisio Aug(usti) l(iberto). En los otros dos tituli, aunque incompletos, aparecen otros dos personajes.

Dada la proximidad cronológica del titulus del año 227 y el del año 229 hay que preguntarse si cada año “cambió” la persona encargada de la *comparatio*, o si existían oficinas distintas en las que actuaban agentes distintos.

### 6.3 Pregunta C (*Decimus Caecilius Hospitalis*)

Partimos del nombre de un personaje: D(ecimus) Caecilius Hospitalis. Buscamos inscripciones, ya sean anfóricas como monumentales (base de datos de Heidelberg) que hagan referencia a dicho personaje. Encontramos numerosos tituli picti, algunos de ellos con datación, situada entre el 112 y 154 d.C., por ejemplo:

112: D Caecili Hospitalis  
 112: [DD Caeciliorum]/[Hospi]talis et M[aterni]  
 154: [DD. Ca]eciliorum / [Hospital]is et Materni

De entre las inscripciones proporcionadas por Heidelberg, una de ellas tiene datación (101-200 d.C.), y su lugar de hallazgo está situado en la Bética (texto en formato EpiDoc):

101-200: <div type="edition" xml:lang="la"> <head> Text </head> <ab> <lb n="1" /> Caecilia Trophime statuam Pietatis ex <expan> <abbr>testament</abbr> <ex> o </ex> </expan> suo ex <expan> <abbr>arg</abbr> <ex> enti </ex>

</ex> <lb n="2"/> <ex> <abbr>p</abbr> <ex> ondo </ex> </ex> C suo et Caecili Silonis mariti sui nomine  
 poni iussit <lb n="3"/> <ex> <abbr>D</abbr> <ex> ecimus </ex> </ex> Caecilius Hospitalis et Caecilia  
 <ex> <abbr>D</abbr> <ex> ecimi </ex> </ex> <ex> <abbr>f</abbr> <ex> ilia </ex> </ex> Materna et  
 Caecilia <lb n="4"/> Philete heredes sine ulla deductione XX <ex> <abbr>posuer</abbr> <ex> unt </ex> </ex>  
 </ab></div>

El conjunto de información obtenida nos muestra que el personaje está relacionado con los negotiatores olearii de la Bética. Esto nos sugiere una nueva línea de estudio: usar términos como mercator, negotiator, diffusor olearius, corpus oleariorum, ... para encontrar otros personajes y establecer las relaciones entre ellos.

#### 6.4 Pregunta D (año 149 d.C.)

Seleccionar todos los tituli picti de un determinado año y relacionar tanto el contenido de los tituli delta (relativos al control fiscal) con los tituli beta (relativos a los personajes relacionados con el mundo del comercio) y en su caso con los sellos que porten esas ánforas. Para el caso del año 149, algunos ejemplos de tituli beta y delta que aparecen en una misma ánfora (con sus sellos, si los tienen), son los siguientes:

Beta: L. · Ant[oni] Plebeian[i]

Delta: acc(---) Max(imus) Orfito et pr[isco cos] / Iuliani XXX[I]I lacca / CX[C]III Sever(us)

No hay sellos

Beta: L. Antoni Epaphroditi

Delta: act(---) Polycar[pus] Orfito et Prisco cos / Sepulei Campani XXXVIII Astig(---) / Martial CCXVI XVI

No hay sellos

Beta: [-----]tonis

Delta: [---] II [-----] / [-----] AAA[-----] / Orfito et [Prisco cos]

Sello: |Q·F·F'|

El análisis del resultado de este tipo de preguntas nos permite:

- Establecer las relaciones entre determinados comerciantes y los lugares precisos de embarque en la Bética de las ánforas.
- Establecer similitudes y diferencias entre los diversos tituli delta de un mismo año.
- Comparar el contenido y la estructura de los diversos tituli delta para completar y mejorar la lectura de los ejemplares fragmentados.
- Definir diferencias o coincidencias en la estructuras de los tituli picti ordenados por las diversas zonas fiscales (Astigis, Corduba, Hispalis).

#### 7. CONCLUSIÓN Y TRABAJO FUTURO

En este artículo se resume el diseño e implementación del sistema OBDA puesto en marcha en el contexto del proyecto EPNet. La tecnología OBDA ayuda a tratar de manera sólida y eficiente

el acceso a los datos, así como la integración y la consistencia de los mismos. Está planeada la integración de nuestro conjunto de datos con otros realizados por distintas iniciativas e investigadores. También está previsto explorar la aplicación de técnicas de minería de texto para extraer de manera automática información del contenido epigráfico del corpus (por ejemplo, nombres de persona, profesiones, lugares, etc.), yendo pues más allá de la descripción sintáctica de la conservación de las inscripciones, y completando así la información ya presente en nuestro conjunto de datos.

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## THE WINE ECONOMY IN ROMAN *HISPANIA*. ARCHAEOLOGICAL DATA AND MODELLIZATION

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«...*Hispaniae coccolobim vocant, rarior uva, aestus austrousque tolerat, capiti inimica, copia larga*»<sup>1</sup>

*Gaius Plinius Secundus, Naturalis Historia XIV, IV, 29*

The establishment of a “wine economy” in *Hispaniae* between the end of the Republican period and the early centuries of the Empire is an essential area of study for various reasons.

Firstly, because of its place in the economy of various territories and its impact on social structures as a particular form of personal enrichment that could lead to the advancement of certain social groups<sup>2</sup>. This impact is determined by the coming together of a set of agricultural, artisan and commercial activities that were organized and coordinated with the aim of producing a surplus for export. These activities, which used complex forms of work, technology and management, influenced the organization of other areas of the economy and the configuration of the territory. In this respect, studying the evolution of the wine economy is a central element when analysing the

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<sup>1</sup> “The *coccolobis* vine in *Hispaniae* has its bunches less tight. It tolerates heat and southerly winds. Its wine produces headache but the output is very abundant” (commentary on Pliny the Elder’s Book XIV by M. L. ARRIBAS HERNÁNDEZ, 2010).

<sup>2</sup> On the relationships between economic development and space in different scales (city, region, province): P. LEVEAU, ‘Échelles d’anthropisation et archéologie des campagnes de Gaule du sud à l’époque romaine’, *Méditerranée*, vol. 4, 1998, pp. 17-26.

social and economic structures of certain regions of the Iberian Peninsula. In particular it may help us to understand their unequal urban development and the wealth of the Hispanian elites, some of whom established strong connections with the central power in the 1st and 2nd centuries AD<sup>3</sup>.

Secondly, the wine economy is a historical-cultural “indicator”. In most of the publications on *Hispania* that have appeared in recent decades, it is possible to find an image of the cultural change that uses, as one of its arguments, the spread of certain strategies and certain forms of work and technology in agriculture and other spheres. This has enabled the change, sparked by the Roman conquest and encouraged by Roman power, to be defined as a form of historical progress. This is clearly just another (although somewhat more sophisticated) way of presenting Romanization as a one-way process<sup>4</sup>. Certain agricultural products like wine and oil, which occupied a special place in the cultural mindset and in Roman life, thus take on the function of a catalyst, but also the value of a symbol. Their production and consumption, which reached all social groups, would apparently show the *romanitas* of a territory and its communities. In this perspective, hispanic viticulture also provides an interesting historiographic exercise in that studying it helps us to reconstruct some of the ways in which scholarly research has analysed the formation of a provincial society.

The aim of this study is to analyse some aspects of viticulture in *Hispaniae*, in particular those relating to the organization of the winemaking process and artisan production (especially the manufacture of amphorae). The analysis focuses on production technology and transport, the organization of the rural habitat and forms of work and management. We also plan to outline the difficulties of interpreting the evidence in economic and social terms in order to understand viticulture’s place in the global context of the Iberian Peninsula economy.

In this context, the wine economy is understood as a situation that includes all the aspects of production needed to produce wines of various qualities, along with a group of complementary activities related to product distribution. The bibliography is very extensive<sup>5</sup>. The spatial and

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<sup>3</sup> It is the case of cities such as *Barcino*, *Tarraco*, *Saguntum*, *Valentia*, *Hispalis*, *Corduba*, or *Gades*.

<sup>4</sup> The rapid spreading of new technology introduced by the Roman conquest in economy and life forms constituted one of the bases in the romanization paradigm uphold until recently: cf. P. LEVEAU, ‘El desenvolupament regional a la Gàl·lia Narbonesa: l’aportació de la paleoecologia i de l’arqueologia de prospecció’, in J. GUITART, J.M. PALET & M. PREVOSTI (eds.), *Territoris antics a la Mediterrània i a la Cossetània oriental. Actes Simposi Internacional d’Arqueologia del Baix Penedès (El Vendrell, 8-10 nov. 2001)*, Barcelona, Departament de Cultura de la Generalitat, 2003, p. 91; Hispania: V. REVILLA, ‘Agrarian Systems in Roman Spain: archaeological approaches’, in P. P. FUNARI, R. S. GARRAFONI, & B. LETALIEN (eds.), *New Perspectives on the Ancient World: Modern perceptions, ancient representations*, Oxford, Archaeopress, 2008, pp. 121-122.

<sup>5</sup> J. MIRÓ, *La producción de ánforas romanas en Catalunya. Un estudio sobre el comercio del vino de la Tarraconense (siglos I a.C.-I d.C.)*, Oxford, Archaeopress, 1988; R. ETIENNE & F. MAYET, *Le vin hispanique*, Paris, Diffusion de Boccard, 2000; V. REVILLA, *Producción cerámica, viticultura y propiedad rural en Hispania Tarraconensis (siglos I a.C.-III d.C.)*, Barcelona, L’Estaqürot, 1995; V. REVILLA, ‘Ánforas y epigrafía anfórica en Hispania Tarraconensis’, in J. REMESAL (ed.), *Epigrafía anfórica*, Barcelona, Publicacions de la Universitat de Barcelona, 2004, pp. 159-196; J. TREMOLEDA, *Industria y artesanado cerámico en época romana en el nordeste de Cataluña (Época augustea y altoimperial)*, Oxford, Archaeopress, 2000; M. PREVOSTI, ‘L’arqueologia del vi a l’àrea costanera de la Tarraconense. Una reflexió’, in M. PREVOSTI, A. MARTÍN OLIVERAS (eds.), *El vi tarraconense i laietà: ahir i avui. Actes del simpòsium*, Tarragona, Institut Català d’Arqueologia Clàssica, 2009, pp. 249-259; A. MARTÍN i OLIVERAS, ‘Arqueología del vino en época romana: El Proyecto *Cella Vinaria* y el complejo vitivinícola de Vallmora (Teià - Maresme – Barcelona). Nuevas aportaciones a la investigación’ in J. M. NOGUERA & J. A. ANTOLINOS (eds.), *De vino et oleo Hispaniae. Áreas de producción y procesos tecnológicos del vino y el aceite en la Hispania romana. Coloquio Internacional (MURCIA, 2010)*, Anales de Prehistoria y Arqueología, 27-28, pp. 101-122; A. MARTÍN i OLIVERAS, ‘Arqueología del Vino en Época Romana: Teoría económica, lógica productiva y comercial aplicada al envasado, la expedición, el transporte y la distribución de ánforas vinarias del nordeste peninsular (s. I a.C.-I d.C.)’, in V. MARTÍNEZ FERRERAS (ed.) *La difusión Comercial de las Ánforas Vinarias de Hispania Citerior Tarraconensis (s.I aC-I dC)*, Oxford, Archaeopress, 2015, pp. 19-38; A. MARTÍN i OLIVERAS, *Arqueologia del vi a l’època romana. Del cultiu al consum. Marc teòric i epistemològic*, Barcelona, Societat Catalana d’Arqueologia, 2015; methodological observations in

chronological framework proposed covers the Eastern area of *Hispania Citerior Tarraconensis* and the province *Ulerior Baetica* between the 2nd-1st centuries BC and the 2nd-3rd centuries AD<sup>6</sup>. In these centuries certain areas of the Peninsula developed a productive economy that was included in the great Mediterranean circuits of exchange, exporting a wide range of resources, agricultural products and manufactured goods. This evidence, rigorously analysed in recent years, enables us to place this provincial viticulture in a wider context. The frame of reference for the analysis is the epistemological and methodological renewal that has taken place in studies of the economy of Rome in recent years<sup>7</sup>.

#### A HISTORIOGRAPHICAL OUTLINE

Contributions from archaeology over the last few decades have made it possible to gain a deeper knowledge of the history of viniculture in various areas of the Iberian Peninsula. This progress has followed a series of phases, defined by the incorporation of successive categories of documentation. For much of the 20th century the analysis centred on cataloguing literary sources that included references to wine. Not only the various histories of *Hispaniae*, both general and regional, but also specific studies of its economy have used these sources as the main basis for constructing a geography of production or assessing in purely qualitative terms the importance of Hispanian viticulture<sup>8</sup>. The sparse archaeological evidence in the shape of excavations of *villae* or pottery workshops was relegated to illustrating the spread of Roman agricultural technology<sup>9</sup>.

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V. REVILLA, 'Viticultura, territorio y hábitat en el litoral nororiental de *Hispania Citerior* durante el Alto Imperio', in J. M. NOGUERA & J. A. ANTOLINOS (eds.), *De vino et oleo Hispaniae, Áreas de producción y procesos tecnológicos del vino y el aceite en la Hispania romana. Coloquio Internacional* (MURCIA, 2010), *Anales de Prehistoria y Arqueología* 27-28, 2011-2012, pp. 67-83; V. REVILLA, 'Agricultura, artesanado rural y territorio en el noreste de *Hispania Citerior*: estructuras y dinámicas', in V. MARTÍNEZ (ed.), *La difusión comercial de las ánforas vinarias de Hispania Citerior Tarraconensis (siglos I a.C. -I d.C.)*, Oxford, Archaeopress, 2015, pp. 1-17; P. SAEZ, 'El vino en la Bética romana', in J. J. IGLESIAS (Coord.), *Historia y cultura del vino en Andalucía*, Universidad de Sevilla, Sevilla, 1995, pp. 13-32. Several conferences have been devoted to this subject: *I Col·loqui Internacional d'Arqueologia romana. El vi a l'Antiguitat. Economia, producció i comerç al Mediterrani occidental* (Badalona 1985), Badalona, 1987; *II Col·loqui Internacional d'Arqueologia Romana. El vi a l'Antiguitat*, (Badalona, 1998), Badalona, 1998; S. CELESTINO (ed.), *El vino en la antigüedad romana. Simposio de arqueología del vino (Jérez, 2, 3 y 4 de octubre de 1996)*, Madrid, 1999; *La producció i el comerç del vi a l'Antiguitat. Economia, producció i comerç al Mediterrani occidental, Les àmfores de la província Hispania Tarraconensis. Homenatge a Ricard PASCUAL i Guasch (Barcelona, 2005)*, Barcelona, 2008; *El Vi Tarraconense i Laietà. Ahir i Avui. Actes del simposium*. (Tarragona i Teià 2007), Tarragona, Institut Català d'Arqueologia Clàssica, 2009.

<sup>6</sup> On viticulture (context): P. SAEZ, *Agricultura romana de la Bética*, Universidad de Sevilla, 1987; P. SILLIERES, 'La Península Ibérica', in Ph. LEVEAU, P. SILLIERES, J.-P. VALLAT (eds.), *Campagnes de la Méditerranée romaine. Occident*, Paris, Hachette, 1993, pp. 201-249; also: M. PREVOSTI, 'L'època romana', in E. GIRALT (dir.), *Història agrària dels Països Catalans*, vol. I, *L'antiguitat*, J. GUITART (coord.), Barcelona, Publicacions de la Universitat de Barcelona, 2005, pp. 345-445. Tecnología: J. M. NOGUERA & J. A. ANTOLINOS (eds.), *De vino et oleo Hispaniae, Áreas de producción y procesos tecnológicos del vino y el aceite en la Hispania romana. Coloquio Internacional* (MURCIA, 2010), MURCIA, 2011-2012.

<sup>7</sup> Discussion on the nature of ancient economy: J. ANDREAU, 'Présentation: Vingt ans après L'Économie antique de Moses I. Finley', *Annales ESC*, vol. 50, num. 5, 1995, pp. 947-960; new approaches: K. GREENE, *The archaeology of the Roman economy*, Berkeley-Los Angeles, University of California Press, 1990; R. P. SALLER, 'Framing the Debate over Growth in the Ancient Economy', in W. SCHEIDEL & S. VON REDEN (eds.), *The Ancient Economy*, Edinburgh, Edinburgh University Press, 2002, pp. 251-269; A. BOWMAN & A. WILSON, *Quantifying The Roman Economy. Methods and Problems*, Oxford, Oxford University Press, 2009; A. BOWMAN & A. WILSON, *The Roman Agricultural Economy: Organization, Investment and Production*, Oxford, Oxford University Press, 2013; D. W. JONES, *Economic Theory and the Ancient Mediterranean*, Hoboken-New Jersey, Wiley-Blackwell, 2014.

<sup>8</sup> J. M. BLÁZQUEZ, *Economía de la Hispania romana*, Bilbao, Nájera, 1978; A. MONTENEGRO & J. M. BLÁZQUEZ, *Historia de España, t. II, España romana (218 a. De J.C.-414 de J.C.)*, vol. I, 'La conquista y la explotación económica', Madrid, Espasa Calpe, 1982; L. CURCHIN, *Roman Spain. Conquest and Assimilation*, London, Routledge, 1991. B. LOWE draws on many archaeological documentation (*Roman Iberia Economy, Society and Culture*, London, Duckworth, 2009), but insufficiently proven, so some analytical and interpretative errors are committed. Paradoxically, his approach favours the image offered by literary sources on goods such as wine or oil, without regard to its nature as a cultural construct.

<sup>9</sup> REVILLA, *Agrarian Systems*, p.121; the root problem is the role given by the traditional economic history to Archeology and their ability to construct general hypotheses; cf. REVILLA, *Agricultura*, pp. 2-3 y 6.

Developments in archaeology from the 1960s made it possible to introduce a new type of evidence: amphorae and their epigraphy. This was soon bolstered by the finding of many pottery workshops, enabling a number of aspects involving technology and work organization to be explored. The advances made have been more visible in some territories than in others: the coastal and pre-coastal areas of Catalonia and the Valencian Community, the lower and middle courses of the Ebro river, the coastal area of Murcia Region, the Andalusian coast and the Guadalquivir valley and so on. However, this progress has brought its own problems. Possibly influenced by the picture given by the literary sources, research initially limited the analysis of each region's economy to the vicissitudes of a single export product: wine, in the case of the eastern coast of *Citerior*; and oil in the case of the Guadalquivir. This led at the same time to a generalization of the simplified image of an agricultural economy based on a single crop, an image which is having to be qualified due to the increasingly precise archaeological evidence.

At first, the importance given to easily-identifiable documentation in the archaeological record led researchers to study the circulation and dating of amphorae. This made it possible to draw up the first maps of wine consumption, which were simplistically interpreted as expressing the production capacity of this provincial viticulture. At the same time, identifying the centres of production allowed the first hypotheses to be made regarding the expansion of vineyards. Initially these hypotheses were still based on an analysis of the literary sources, while the archaeological evidence was assessed to complement the written texts. This dependence of archaeology on literature can be seen, for example, in the over-simplifying nature of hypotheses aimed at reconstructing the evolution of viticulture in *Citerior* between the 1st century BC and the 3rd century AD<sup>10</sup>.

In recent years the progress on field research has shown itself to be an essential resource for defining the geography of vineyards, since the technological evidence relating to the production and storage of wine or the manufacture of amphorae can, in many cases, be located and dated with great accuracy. However, in this area, also, there is a number of problems with its interpretation. The manufacture of amphorae was part of a wider artisan production process, given that the making of amphorae cannot be taken in isolation from the making of other ceramic products. Artisan topography therefore does not exactly match the location of vineyard areas. Neither does the simple presence of winemaking technology make it possible to systematically specify the exact strategies and forms of production associated with the spread of vineyards over a territory. Not to mention the so-called "local vineyards", which were used to produce wine for personal consumption or for sale in strictly local markets and which have left little archaeological traces<sup>11</sup>.

Archaeology's contribution has been just as essential as regards increasing our knowledge of the rural habitat and of how the territory was occupied and exploited<sup>12</sup>. Advances in this sphere, helped by renewed methodology and an increase in rigorous excavations, have enabled types of settlement to be identified, distribution patterns to be reconstructed and specific ways of using technology to

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<sup>10</sup> MIRÓ, *Producción de ánforas*, pp. 295ff.; cf. REVILLA, *Agrarian Systems*, pp. 120-121.

<sup>11</sup> A. TCHERNIA, *Le vin de l'Italie romaine. Essai d'histoire économique d'après des amphores*, Roma, École Française de Rome, 1986, pp. 37-39, 296.

<sup>12</sup> Bibliography on rural settlement is difficult to summarise. Traditional historiography: J. G. GORGES, *Les villas hispano-romaines. Inventaire et Problématique archéologiques*, Paris, Centre Pierre Paris, 1979, and M. PONSICH, *Implantation rurale antique sur le Bas-Guadalquivir*, I-IV, Madrid-Paris, Casa de Velázquez, 1974-1991. Works included in recent conference proceedings: V. REVILLA, J. R. GONZÁLEZ & M. PREVOSTI, *Actes del Simposi Les vil·les romanes a la Tarraconense. Implantació, evolució i transformació. Estat actual de la investigació del món rural en època romana (Lleida, 28-30 novembre 2007)*, Barcelona, Museu d'Arqueologia de Catalunya, 2008-2011; R. HIDALGO, M. BUZÓN & J. R. CARRILLO, *Villas romanas en Andalucía. Novedades y últimos hallazgos, Rómula*, 12-13, Sevilla, Universidad Pablo de Olavide, 2013-2014.



be defined<sup>13</sup>. The new data make it possible to relate how the territory was occupied to specific management and production strategies. In the same context, the analysis of rural artisan centres has been fundamental for understanding the relationships between agriculture and other activities and, ultimately, for perceiving the economic importance of viticulture<sup>14</sup>.

Nevertheless, it needs to be pointed out that there are a number of problems of an epistemological nature within the general framework of the research. First, no attempt has been made to carry out an in-depth analysis of the impact that the development of a wine economy had on the evolution of Hispanian provinces in the High Empire and, in particular, the consequences this economy may have had for the configuration of the social structure, assuming that it did actually offer real possibilities for personal enrichment and involved transfer of wealth and the concentration of property and resources. Neither was it our aim to carry out a mesoscale or microscale study of the impact that the wine economy may have had on the evolution of certain urban communities<sup>15</sup>, a situation so out of balance that, a priori, it could deter us from attempting a global analysis of the economic structures of a region or province.

Analysis is also made difficult by the scant development of research into certain areas involving other crops, vegetation and landscape, and by the thoroughly heterogeneous character of this wine economy, which included a range of very different “qualities” and vineyards, from great wines to common wines for domestic consumption. The objectives, the resources invested, the forms of production and management and the possibilities associated with the making of each type of wine were very different. In this context the economic importance of other crops such as cereals should also be assessed<sup>16</sup>.

Finally, there is no complete study on the importance of exports. The few attempts made so far, including the seminal work of Jordi Miró, are incomplete. The most recent literature concentrates on analysing shipwrecks or specific places where the proportion of amphorae from *Citerior* as opposed to those from elsewhere can be established. Many of these studies are undeniably important, as in the case of Rome and other western cities, military settlements, etc., but the choice of these places was determined by the research subject and the quality of the information available, which makes it impossible to reconstruct a systematic global picture.

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<sup>13</sup> REVILLA, *Agricultura*, Y. PEÑA, *Torcularia. La producción de vino y aceite en Hispania*, Tarragona, Institut Català d'Arqueologia Clàssica; 2010.

<sup>14</sup> On modern Catalonia: REVILLA, *Producción Cerámica*; TREMOLEDA, *Industria y artesanado cerámico*; J. TREMOLEDA, 'Les instal·lacions productives d'àmfores tarraconenses', in *La producció i el comerç de les àmfores de la província Hispania Tarraconensis. Homenatge a Ricard Pascual i Guasch (Barcelona, 17 i 18 de novembre de 2005)*, Barcelona, Museu d'Arqueologia de Catalunya, 2008, pp. 113-150.

<sup>15</sup> Except for the case of freedmen: O. OLESTI & C. CARRERAS, 'Esclavos y libertos en la producción vinícola y alfarera en el *ager Barcinonensis*: de la marginalidad al éxito económico', in F. Reduzzi Merola (ed.), *Dependenza ed emarginazione nel mondo antico e moderno. Atti del 33 Convegno G.I.R.E.A.*, Napoli, Aracne, 2012, pp. 309-333; O. OLESTI & C. CARRERAS, 'Le paysage social de la production vitivinicole dans l'*ager Barcinonensis*', *Dialogues d'Histoire Ancienne*, vol. 39, num. 2, 2013, pp. 147-189. On the same subject: J. PONS, 'Algunas consideraciones teóricas sobre el sevirato como indicador de dinamismo socio-económico', *Memorias de Historia Antigua*, vol. I, 1977, pp. 215-219. On the other hand, the identification of some freedmen and several biographical notes on their social life cannot be considered in order to strengthen the traditional freedman image as a businessman who gets a swift social promotion. Few cases are attested in *Hispaniae* and it is not possible to specify neither their legal status nor exact role of most of individuals mentioned on amphoric epigraphy.

<sup>16</sup> P. IZQUIERDO, 'Els ports del litoral tarraconense i el seu paper en el comerç del vi', in M. PREVOSTI & A. MARTÍN OLIVERAS (eds.), *El vi tarraconense i laietà; ahir i avui, Actes del simposium*, Tarragona, Institut Català d'Arqueologia Clàssica, 2009, pp. 179-191; V. REVILLA, 'Hábitat rural y territorio en el litoral oriental de Hispania Citerior: perspectivas de análisis', in J.M. NOGUERA (dir.), *El poblamiento rural romano en el sureste de Hispania. 15 años después, Actas de las II Jornadas sobre Poblamiento rural romano en el sureste de Hispania*, Museo Arqueológico de Murcia, 2009 Murcia, Editum, 2010, p. 45; REVILLA, *Viticultura*, p. 87.

Hispanian wines are occasionally mentioned in the literature between the end of the 1<sup>st</sup> century BC and the mid-2nd century AD<sup>17</sup>. The corpus includes writers from a wide range of social and cultural backgrounds: Greeks and Romans; members of the elite and individuals of more humble origins, some with connections to the same elite as in the case of Martial; people from Italy and people from the provinces. The same can be found in the genres used. It is interesting to see how the information provided by the literature is organized in different ways and presents different features in each period. The earliest passages are similar in their geographical vagueness and the frequently negative comments made about the wine. Ovid is a good example of this, since he only mentions Hispanian wine in order to criticize it (*Ars Amatoria* III, 645). Only Strabo relates wine production to a geographic location, namely Turdetania (III, 2, 6), but it is a generic mention, referring only to its abundance in the context of a routine inventory of the region's riches that are exported and therefore subject to taxation. This lack of precision paradoxically coincides with the regular presence of Hispanian wines in the Western Empire and Rome during the Augustan period and the first half of the 1st century AD, which has been well established through archaeology<sup>18</sup>.

The situation at the end of the 1st century AD and the beginning of the 2nd is different. A number of writers from the Flavian and Trajan periods mention specific qualities and geographic areas of origin. In some cases the distinction between what are considered to be high "quality" wines and others is explicit. Pliny the Elder, in particular, establishes a clear distinction between vineyards and grape varieties with limited production, which give us great wines of the first and second rank, and other vineyards and grape varieties that give us common wines of the third and fourth rank. These latter wines can be termed as "high consumption" due to their mass production, and this group would include some of the wines produced on the central Catalan coast: "*Hispaniarum Laeetana copia nobilantur*" (*H.N.* 14.71)<sup>19</sup>. Other authors, such as Martial (1.26.9-10; 7.53.6; 13.118), Juvenal (5.29-30), Silius Italicus (3.369-370 and 15.176-177) and Fronto (*Ep. De eloquentia*, 1.1), give both positive and negative subjective assessments. A special case is Florus (*Vergilius orator an poeta* 2.8), who uses a generic reference to vineyards to construct an ideal picture of *Tarraco*.

The high number of quotations involving Hispanian wine in this period stands in contrast to the panorama provided by the archaeological record, since wine amphorae from both *Citerior Tarraconensis* and *Baetica* appear in very small quantities in the stratigraphies of Ostia and Rome<sup>20</sup>. This highlights another apparent contradiction between literature and archaeology, although this could be overcome if we see the literary testimonies as being part of a cultural discourse rather than a direct "reflection" of an economic phenomenon. The repeated mentions of quality of the wines from Hispania coincide, and this seems significant, with the social and political presence of Spanish elites in Rome in the second half of the 1st century AD. This would explain some of the attention given in the literary sources to certain Hispanian products that were consumed by Rome City's elite and it cannot

<sup>17</sup> TCHERNIA, *Vin*, pp. 273-274; MIRÓ, *Producción de ánforas*, pp. 295ff.; O. GIRALT, 'El conreu de la vinya a la Hispania romana a través de les fonts escrites', in *Jornades sobre la viticultura de la conca mediterrània*, 1986, Bellaterra, Universitat Autònoma de Barcelona, 1995, pp. 332-343.

<sup>18</sup> MIRÓ, *Producción de ánforas*.

<sup>19</sup> These differences have been spelled out by TCHERNIA, *Vin*, pp. 28-29.

<sup>20</sup> Dressel 2-4 from *Citerior* and Haltern 70 from *Baetica* seem residual finds in 2nd century AD archaeological levels from Ostia and Rome. Other amphora types such as Pascual 1 and Oberaden 74 are not longer being used for trade by mid-1st century AD or even before: MIRÓ, *Producción de ánforas*; G. RIZZO, 'Ostia VI. Le Terme del Nuotatore. Le anfore, Ostia e i commerci mediterranei', in C. PANELLA & G. RIZZO, *Ostia VI. Le Terme del Nuotatore, Studi Miscellanei*, vol. 38, 2014, pp. 198-199 y 205-206.

be ruled out that these same elites may have introduced some of their consumption habits and that they themselves may have produced some of the wines. In this historical context a geography of production could be compiled, defined by placing certain wines into an urban framework that could function as a specific “designation of origin” (*Tarraco, Lauro, Saguntum*, etc.). This geography could also be linked to territories corresponding to a regional origin (Laetanian wine) or geographic provenance (the Balearic Islands wine) reality<sup>21</sup>. In any event, no writer mentions technological, productive, legal or financial aspects relating to the production and commercialization of Hispanian wine. Neither do they provide data on the making of different quality wines. The closest we get is the distinction made by Pliny the Elder mentioned earlier, but always from the subjective point of view of the consumer<sup>22</sup>. The quotations also present problems of accuracy and context. In some cases the data collected may be contemporary with the writing of the text, but in others they could be anachronisms.

In short, the case of wine shows how any attempt to reconstruct a production phenomenon comes up against the limits imposed by Roman society’s value system, which denies the economy’s autonomy with regard to the social and political order. References to viticulture therefore always appear as part of a discourse that brings together wine quality, forms of consumption, situations, ritualized spaces of use and *status*. The mechanisms used to make the product’s material and cultural value explicit are the interplay of comparisons and the description of the context in which the product is consumed. This explains the description of a hierarchy of wines in Pliny, the diversity of particular consumption situations and the references to the consumers’ condition that appear in other authors such as Ovid, Martial and Juvenal.

#### VITICULTURE IN HISPANIA CITERIOR TARRACONENSIS

Over the last few decades the contributions of archaeological research have resulted in a deeper knowledge of the history of viticulture on the Mediterranean coast of *Hispania Citerior*<sup>23</sup>. This is especially obvious in specific areas, such as the typology of the amphorae used to transport the region’s wines and their system of epigraphic representation<sup>24</sup>. A great many artisan centres

<sup>21</sup> Pliny’s statement on insular wines can be contrasted with a specific amphora production in Ibiza, between the Carthaginian period and the end of Antiquity. Peninsular amphorae were reproduced in early Roman imperial times. J. RAMON, ‘Les àmfores altimperial d’Ebusus’, in *La producció i el comerç de les àmfores de la província Hispania Tarraconensis. Homenatge a Ricard PASCUAL i Guasch (Barcelona, 17 i 18 de novembre de 2005)*, Barcelona, Museu d’Arqueologia de Catalunya, 2008, pp. 241-270; J. RAMON, ‘La ceràmica ebusitana en la Antigüedad Tardía’, in D. BERNAL & A. RIBERA (eds.), *Cerámicas Hispanorromanas, Un estado de la cuestión*, Cádiz, Universidad de Cádiz, pp. 563–583.

<sup>22</sup> V. REVILLA, ‘La producció anfòrica en el sector meridional de Catalunya: pràctiques artesanals, viticultura i representacions culturals’, in *La producció i el comerç de les àmfores de la província Hispania Tarraconensis. Homenatge a Ricard PASCUAL i Guasch (Barcelona, 17 i 18 de novembre de 2005)*, Museu d’Arqueologia de Catalunya, Barcelona, Museu d’Arqueologia de Catalunya, 2008, pp. 217-220.

<sup>23</sup> R. PASCUAL, ‘Centros de producción y difusión geográfica de un nuevo tipo de ánfora’, in *VII Congreso Nacional de Arqueología (Barcelona, 1960)*, Zaragoza, 1962, pp. 334-345; R. PASCUAL, ‘Las ánforas de la Layetania’, in *Méthodes classiques et méthodes formelles dans l’étude des amphores (Roma, 1974)*, Roma, École Française de Rome, 1977, pp. 47-96; A. TCHERNIA, ‘Les amphores vinaires de Tarraconaise et leur exportation au début de l’Empire’, in *Archivo Español de Arqueología*, vol. 44, 1971, pp. 38-85; MIRÓ, *Producción de ánforas*; REVILLA, *Producción cerámica* 1995; REVILLA, *Ánforas y epigrafía, passim*; TREMOLEDA, *Industria cerámica*.

<sup>24</sup> MIRÓ, *Producción de ánforas*, pp. 210-226; R. PASCUAL, *Índex d’estampilles sobre àmfores catalanes*, Barcelona, L’Estaqüiro, 1991; V. REVILLA, ‘Onomástica en epigrafía anfòrica de la Hispania Tarraconense: algunas consideraciones sobre su significado y métodos de análisis’, in M. MAYER, G. BARATTA & A. GUZMÁN (eds.), *Acta XII Congressus internationalis epigraphiae graecae et latinae, Barcelona, provinciae Imperii Romani inscriptionibus descriptae, Barcelona, 3-8 septembris 2002*, Barcelona, 2007, pp. 1183-1192; P. BERNI & V. REVILLA, ‘Los sellos de las ánforas de producción tarraconense: representación y significado’, in *La producció i el comerç de les àmfores de la província Hispania Tarraconensis. Homenatge a Ricard PASCUAL i Guasch (Barcelona, 17 i 18 de novembre de 2005)*, Barcelona, Museu d’Arqueologia de Catalunya, 2008, pp. 95-111; A. LÓPEZ & A. MARTÍN MENÉNDEZ, ‘Tipología i datació de les àmfores

have also been located, and this has made it possible to define certain aspects of technology and work organization. In addition to this, archaeology has provided reliable information regarding the organization of the rural habitat, technology and how the territory was occupied.

The establishment of viticulture in the province is related to the thorough transformations brought about by the Roman conquest. Especially interesting in this respect is the existence of early wine production in the territory of *Tarraco* and close to the indigenous *oppida* of the central Catalan coast, which survived until the mid-1st century BC. This phenomenon is already confirmed in the final third of the 2nd century BC, in connection with the global transformation of the settlement and production structures<sup>25</sup>. This development brought with it a need to manufacture specific containers for transport, in the form of imitations of the Dressel 1 and Lamboglia 2 Italic amphorae<sup>26</sup>. However, the spread of vineyards geared towards commercialization in overseas markets did not come about until the second half of the 1st century BC, specifically in the final third of that century. This is confirmed by the foundation chronologies of many pottery workshops and numerous *villa*-type settlements and other rural centres, equipped with facilities for pressing and storing wine production. This incipient viticulture can be found in certain territories of the central Catalan coastline (see Maps 1&2)<sup>27</sup>.

A series of regional situations can be identified within *Citerior*, partly as a result of developing the research differently. In the north-east of the Peninsula, in what is today Catalonia, the geography of vineyards can be reconstructed with a fair degree of certainty. An especially dense concentration of evidence can be seen on the central coastline to the north of Barcelona, which seems to have been the preferred area for planting vineyards geared for export from the beginning of the Augustan period, while various vineyard areas have also been identified at some points of the Girona coastline, the coast of Garraf-Penedès, the Camp de Tarragona and the lower course of the Ebro river<sup>28</sup>.

Viticulture spread rapidly after the change of era and throughout the first half of the 1st century AD, covering new territories or exploiting more intensively those spaces that were already occupied. This expansion appears to have been detected to the west of the *ager Tarraconensis*, especially in the area closest to *Tarraco*. It also affected the area situated between the rivers

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Tarraconenses produïdes a Catalunya', in *La producció i el comerç de les àmfores de la província Hispania Tarraconensis. Homenatge a Ricard PASCUAL i Guasch (Barcelona, 17 i 18 de novembre de 2005)*, Barcelona, Museu d'Arqueologia de Catalunya, 2008, pp. 33-94; A. LÓPEZ MULLOR & A. MARTÍN MENÉNDEZ, 'Las ánforas de la Tarraconense', in D. BERNAL & A. RIBERA (eds.), *Cerámicas hispanorromanas. Un estado de la cuestión*, Cádiz, Universidad de Cádiz, 2008, pp. 689-694.

<sup>25</sup> M. MIRET, J. SANMARTÍ & J. SANTACANA, 'From indigenous structures to the Roman world: models for the occupation of central coastal Catalonia', in G. Barker & J. Lloyd (eds.), *Roman Landscapes. Archaeological survey in the Mediterranean region*, London, British School at Rome, 1991, pp. 47-53; V. REVILLA, 'El poblamiento rural en el noreste de Hispania entre los siglos II a.C. y I d.C.: Organización y dinámicas culturales y socioeconómicas', in P. Moret & T. Chapa (eds.), *Torres, atalayas y casas fortificadas. Explotación y control del Territorio en Hispania (S. III a. de C. – S. I d. de C.)*, Jaén, Universidad de Jaén, 2004, 175-202; V. REVILLA, 'Rural Settlement in the central littoral area and the interior regions of Catalonia in the 1st and 2nd centuries BC', in *Time of Changes. In the beginning of the Romanization*, Girona, Universitat de Girona, 2010, pp. 139-159.

<sup>26</sup> LÓPEZ MULLOR & MARTÍN MENÉNDEZ, *Ánforas de la Tarraconense*, pp. 689-694.

<sup>27</sup> REVILLA, *Producción cerámica*, pp. 122-125; REVILLA, *Producción anfórica*, pp. 198 and 202.

<sup>28</sup> General approach: MIRÓ, *Producción de ánforas*, pp. 12-59; REVILLA, *Producción cerámica*, pp. 161-286. Specific approaches: P. CASTANYER, J. M. NOLLA & J. TREMOLEDA, 'La producció vinícola en època romana a les comarques gironines. Inversió, propietat, treball de la terra i artesanat', in M. PREVOSTI & A. MARTÍN OLIVERAS (eds.), *El vi tarraconense i laietà: ahir i avui. Actes del simposium*, Tarragona, Institut Català d'Arqueologia Clàssica, 2009, pp. 42-59; R. JÀRREGA, 'La producció vinícola i els tallers d'àmfores a l'ager Tarraconensis i a l'ager Dertosanus', in M. PREVOSTI & A. MARTÍN OLIVERAS (eds.), *El vi tarraconense i laietà: ahir i avui. Actes del simposium*, Tarragona, Institut Català d'Arqueologia Clàssica, 2009, pp. 99-123; R. JÀRREGA, 'Producción anfórica, figlinae y propiedad en el territorio de Tarraco (Hispania Citerior): últimas aportaciones', in D. BERNAL et al. (eds.), *Hornos, talleres y focos de producción alfarera en Hispania, Actas del primer congreso de la SECAH (Cadiz)*, volumen 2, Madrid, 2013, 399-410.



*Rubricatum* (Llobregat) and Besós, reorganized with the founding of the colony of *Barcino*. These rivers connected the colony with the interior of the territory, ensuring access to other agricultural spaces and their resources. This makes it possible to understand the economic development of *Barcino* in the 1st and 2nd centuries AD (see Map 1)<sup>29</sup>.

A similar process seems to have developed in the coastal area north of the Besós. In this geographic space, originally organized around two *municipia* founded in the late Republican period - *Baetulo* and *Iluro* - and the small *oppidum* of *Blanda* or *Blandae* situated at the mouth of the river *Arnum* (Tordera), where the *villa* system had been strongly established since the Augustan period. From a time well into the 1st century AD, the economic interests of important families from the colony of *Barcino* would become a consolidated presence in this area<sup>30</sup>.

The spread of viticulture from the beginning of the 1st century AD was accompanied by changes in the organization of artisan activities. It was at this time, in areas such as the river Llobregat, where large-scale pottery workshops with a complex internal organization appeared, whose purpose was to meet the varied demand generated by the *villa*'s economical system nearby *Barcino*<sup>31</sup>. This new production situation would also coincide with changes in how exchanges were organized (see below). Other areas of inland Barcelona, Girona and Lleida appear to have been occupied by vineyards that were aimed at satisfying a more local and regional demand, and which were developed later in association with specific artisan processes<sup>32</sup>.

On the coast of the Valencian Community and the Region of Murcia, viticulture became strongly established between the mid-1st century AD and well into the 3rd century AD. This seems to be related to a gradual change in the way the territory was occupied between the end of the Republican period and the beginning of the Augustan period, driven by colonial settlements<sup>33</sup>. In some cases (the territories of *Saguntum* and *Dianium*), the importance of agricultural and artisan activity suggests the existence of an intense viticulture aimed at commercialization in overseas markets<sup>34</sup>. It is also

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<sup>29</sup> *Tarraco*: REVILLA, Producción anfórica; M. PREVOSTI & J. GUITART, *Ager Tarraconensis 2. El poblament*, Tarragona, Institut Català d'Arqueologia Clàssica, 2010; JÁRREGA, Producció vinícola; JÁRREGA, Producción anfórica; M. PREVOSTI, 'Instalaciones vinícolas y oleícolas estudiadas en el marco del proyecto *ager Tarraconensis* (PAT)', in J. M. NOGUERA & J. A. ANTOLINOS (eds.), *De vino et oleo Hispaniae. Áreas de producción y procesos tecnológicos del vino y el aceite en la Hispania romana. Coloquio Internacional, Anales de Prehistoria y Arqueología*, vols. 27-28, MURCIA, 2011-2012, pp. 97-111; *Barcino*: O. OLESTI, 'Propiedad de la tierra y élites locales; *ager Barcinonensis*' in A. Gonzalès et al. (eds.), *Histoire, Espaces et Marges de l'Antiquité: Hommages à Monique Clavel-Lévêque*, vol. 4, Besançon, 2006, pp. 175-200; O. OLESTI, 'Propietat i riquesa a l'ager Barcinonensis', in C. CARRERAS & J. GUITART (eds.), *Barcino I. Marques i terrisseries d'àmfores al Pla de Barcelona*, Barcelona-Tarragona, Institut d'Estudis Catalans-Institut Català d'Arqueologia Clàssica, 2009, pp. 141-158; OLESTI & CARRERAS, *Esclavos y libertos*, pp.309-333; OLESTI & CARRERAS, *Paysage social*, pp.147-189.

<sup>30</sup> I. RODÀ; A. MARTÍN i OLIVERAS et al., 'Personatges de *Barcino* i el vi laietà. Localització d'un *fundus* dels *Pedanii Clementes* a Teià (El Maresme) a partir de la troballa d'un *signaculum* de plom amb inscripció (segle II dC)', *Quarhis. Quaderns d'Arqueologia i Història de la ciutat de Barcelona*, època II, vol. 1, 2005, pp.47-57.

<sup>31</sup> REVILLA, *Ánforas y epigrafía*, pp. 186-189; REVILLA, *Onomástica*, p.1192; BERNI & REVILLA, *Sellos*, pp. 99-101.

<sup>32</sup> REVILLA, *Viticultura*, pp. 83-84; CASTANYER, NOLLA & TREMOLEDA, *Producció vinícola*, p. 57.

<sup>33</sup> C. FRIAS, *El poblamiento rural de Dianium, Lucentum Ilici y la ciudad romana de la Vila Joiosa (siglos II a.C.-VII d.C.). Bases para su estudio*, Alicante, Publicaciones de la Universidad de Alicante, 2010; on the introduction of new forms of production in the surrounding area of *Carthago Nova*: L. LÓPEZ-MONDEJAR, 'Paisaje y poblamiento en el sureste peninsular entre la República tardía y el Alto Imperio', in J. M. NOGUERA, *El poblamiento rural romano en el sureste de Hispania. 15 años después, Actas de las II Jornadas sobre Poblamiento rural romano en el sureste de Hispania*, Museo Arqueológico de Murcia, 2009, Murcia, Editum, 2010, pp. 71-98; A. J. MURCIA, 'Poblamiento rural romano en el campo de Cartagena (siglos III a.C.-VII d.C.)', in J. M. NOGUERA (ed.), *El poblamiento rural romano*, pp. 141-165.

<sup>34</sup> Production of amphoras of Iberian tradition in the surrounding area of *Saguntum* is stated in: C. ARANEGUI, 'La producción y el comercio de ánforas tarraconenses en el País Valenciano', in *La producció i el comerç de les àmfores de la província Hispania Tarraconensis. Homenatge a Ricard Pascual i Guasch, Actes de les Jornades d'Estudi, 17 i 18 de novembre de 2005*



between the 1st and 2nd centuries AD that we see the development of a large-scale activity producing *garum* and fish preserves, also for export<sup>35</sup>. In contrast, part of the region's agricultural production, especially oil, seems mainly to be destined for meeting internal demand.

Evidence of vitivinicultural production, exported to the Peninsula and elsewhere, has also been found on the island of *Ebusus* (Ibiza). Research has enabled the identification of a number of rural centres with winemaking technology and evidence related to crop-growing systems that indicate intense production from the Late Punic period<sup>36</sup>. Finally, there is important though scattered archaeological evidence of wine production in the Ebro valley and on the Meseta (high central plateau). These remains, in the shape of manufacturing and storage facilities, confirm the existence of surplus production destined for regional commercialization and possibly export. One example would be the *villa* of Arellano in Navarra<sup>37</sup>.

The nature of the new forms of production can be seen in the use of specific technology for making wine. In Catalonia today, for example, over a hundred establishments have so far been identified as having traces of pressing facilities or spaces for storing liquids (mainly wine)<sup>38</sup>. These facilities vary greatly in importance, from modestly-built settlements with a single press to large buildings with four or more presses<sup>39</sup>. This technology was accompanied by all the elements necessary for processing the grapes and must, which shows a desire to organize the whole winemaking process. The commercial orientation seems obvious when a place has a large number of *dolia* and there is a pottery workshop attached for making amphorae. At the same time there is evidence of the systematic use of technical principles applied to the pressing machinery to increase efficiency. These elements spread rapidly from the Augustan period onwards<sup>40</sup>. The spread of this technology, like

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(Barcelona 2007), Barcelona, Museu d'Arqueologia de Catalunya, p. 230. See also: J. A. GISBERT, 'Àmfores i vi al territori de *Dianium* (Dènia). Dades per a la sistematització de la producció amforal al País Valencià', in *II Col·loqui Internacional El Vi a l'Antiguitat. Economia, Producció i Comerç* (Badalona, 1998), Badalona, Museu de Badalona, 1998, pp. 383-412; GISBERT, J. A., 'Vi tarraconense al País Valencià. Una mirada des dels forns d'àmfores. Arqueologia de les vil·les i dels derelictes de la costa de *Dianium*', in M. PREVOSTI & A. MARTIN OLIVERAS (eds.), *El vi tarraconense i laietà: ahir i avui. Actes del simposium*, Tarragona, Institut Català d'Arqueologia Clàssica, 2009, pp. 125-150; E. HUGUET et al., 'Una zona alfarera del Alto Imperio al norte de Valentia', *SFECAG Actes du Congrès de l'Escala-Empúries (1<sup>er</sup>-4 mai 2008)*, Marsella 2008, 159-168.

<sup>35</sup> MURCIA, Poblamiento rural, p. 155.

<sup>36</sup> RAMON, Àmfores altimperial; J. RAMON, 'Economía y comercio de la Ibiza púnica en la época de las acuñaciones de moneda (siglos IV a.C. – I d.C.)', in A. ARÉVALO, D. BERNAL & D. COTTICA (eds.), *Ebusus y Pompeya, ciudades Marítimas. Testimonios monetales de una relación*, Cádiz, Publicaciones de la Universidad de Cádiz, 2013, p. 89; J. J. MARÍ & G. GRAZIANI, 'La producción de vino en la zona central de Ibiza', in M. Riera & J. Cardell (eds.), *Archaeology of Minorca. El Santuario de Calescoves (Alaior, Menorca), V Jornades d'arqueologia de les Illes Balears* (Palma, 28 a 30 de setembre de 2012), Palma de Mallorca, Consell de Mallorca, 2013, pp. 173-180; this wine economy is inserted into a broader picture of overall use of agricultural (olive oil, cereals), natural (salt marshes, forests), fish farming and mining related resources, in turn, with a highly developed commercial structure: RAMON, Economía y comercio, pp. 90-98 y 115-120.

<sup>37</sup> M. A. MEZQUÍRIZ, 'La producción de vino en época romana a través de los hallazgos en territorio navarro', *Trabajos de Arqueología Navarra*, 17, 2004, pp. 133-160.

<sup>38</sup> In the absence of a synthesis study for presses in the whole province, see: PEÑA, *Torcularia*.

<sup>39</sup> Installations equipped with 5-6 presses must be highlighted in the villa of Pont del Treball Digne-La Sagra (Barcelona), see D. ALCUBIERRE, E. HINOJO & A. RIGO, 'Primers resultats de la intervenció a la vil·la romana del Pont del Treball a Barcelona', in *Tribuna d'Arqueologia 2012-2013*, Barcelona, Departament de Cultura de la Generalitat de Catalunya, 2015, pp. 372-398. Installations equipped with 4 presses must be highlighted in Veral de Vallmora, (Teià, Barcelona), see: MARTÍN i OLIVERAS, *Parc arqueològic*, pp. 193-213; and Els Ametllers (Tossa de Mar, Girona), see: L. PALAHÍ & J. M. NOLLA, Felix Turissa. *La vil·la romana dels Ametllers i el seu fundus* (Tossa de Mar, la Selva), Tarragona, Institut Català d'Arqueologia Clàssica, 2010.

<sup>40</sup> MARTÍN i OLIVERAS, Arqueologia del vino, pp. 19-38; MARTÍN i OLIVERAS, *Arqueologia del vi* (with previous bibliography); see also: Y. PEÑA, 'Variantes tecnológicas hispanas en los procesos de elaboración de vino y aceite en época romana', in J. M. NOGUERA & J. A. ANTOLINOS (eds.), *De vino et oleo Hispaniae, Áreas de producción y procesos tecnológicos del vino y el aceite en la Hispania romana. Coloquio Internacional, Anales de Prehistoria y Arqueología*, Murcia, vols. 27-28, 2011-2012, pp. 37-57.

the use of the *arca lapidum* counterweights identified especially in the Catalonia area, is in turn related to the appearance of settlements characterized by a particular architecture and designed for intensive production, which are distributed with varying density across the rural space. This specific distribution is related to different ways of exploiting the territory<sup>41</sup>.



**Fig. 1. Torcularium of Veral de Vallmora (Teià, Maresme, Barcelona) 3D restitution. Illustration: A. Martín i Oliveras & F. Bayés, 2008.**

The most important type of establishment is the *villa*, the management and exploitation centre, which is defined by spatial planning based on differentiating between one sector with all the services necessary for domestic life set aside to the private spaces for the owner, and another sector used for agricultural production. In general, the technology for winemaking, including several presses along with one or more tanks for collecting the must, is found in neighbouring buildings around the residential sector. But they could also be a little further away. Some *villae* had an artisan sector set apart from the residential area.

On a secondary level would be big establishments between 1,500 and 2,000 m<sup>2</sup> in area, with a complex spatial organization and a basically productive function. These places would contain the complex infrastructure needed for making and storing wine on a certain scale: a *torcularia* or pressing room (with from 4 to 6 presses), *calcatoria*, *lacus* and *cellae vinariae* of between 100 and 200 *dolia*. Artisan pottery activities, a forge, etc., have also been identified in most of these places<sup>42</sup>.

Another category includes a wide range of buildings with a simpler spatial organization but also dedicated to agricultural production (from 400/500 to 1000/1200 m<sup>2</sup> in area). Most were used for

<sup>41</sup> Settlement typology: REVILLA, *Hábitat rural y territorio*, pp. 35-42; in the absence of an overall study on the rural settlement in *Hispania Citerior*, see: PREVOSTI, *L'època romana*, pp. 345-445; and REVILLA, GONZÁLEZ & PREVOSTI (eds.), *Vil·les romanes a la Tarraconense*, pp. 19-80. A study on the introduction of the *arca lapidum*-type counterweights in MARTÍN i OLIVERAS, *Anàlisi tecnofuncional*, pp.59-98.

<sup>42</sup> Some examples: E. SÁNCHEZ *et al.*, 'El jaciment romà del Morè. Sant Pol de Mar, Maresme, Barcelona', Departament de Cultura de la Generalitat de Catalunya, 1997; MARTÍN i OLIVERAS, *Parc arqueològic*, pp.193-213.

producing wine and had one or two presses, a *lacus* and a space set aside for storing between 30 and 50 *dolia*. In some places, however, there is evidence of the simultaneous storage of a cereal production, either for personal use or for sale<sup>43</sup>. Some of these establishments had also a pottery workshop where amphorae were made. All this suggests that these were places given over to specialized; intensive work processes forming part of a production structure organized elsewhere, possibly a nearby *villa*. Indeed, some buildings were occupied only seasonally, during certain phases of the agricultural cycle<sup>44</sup>. This organization also points to a regular connection with commercialization structures.

This type of viticulture geared towards exporting to overseas markets would continue, depending on the area, until the mid- or late-2nd or even the early 3rd century AD, judging by the evidence provided by the catalogue of amphorae with specific variants of the Dressel 2-4 Tarraconense form and the sequence of activity of certain pottery workshops and numerous agricultural settlements. In any event, there seem to be a great many local characteristics, as shown by the transformation of both agricultural and artisan centres. These agricultural centres would see the abandonment or reduction of big pressing facilities between the second half of the 2nd and the beginning of the 3rd century AD. In the case of the pottery workshops, some would disappear between the last third of the 1st and the start of the 2nd century AD, while others would convert and diversify their production. This ensured their continuity during the 2nd and 3rd centuries AD.

As mentioned above, a great many *villae* dedicated to winemaking had pottery workshops for making *amphorae* either attached or nearby. It is difficult to reconstruct the ways this artisan activity was organized, given the absence of written information. However, the archaeological documentation and amphora epigraphy supply highly important information in the form of onomastic, topographic and contractual practices.

So far over 90 pottery workshops that were involved in the manufacture of wine *amphorae* have been identified in the north-east of *Hispania Citerior* (see Map 2)<sup>45</sup>.

To these can be added around 20 more in what is today the Valencian Community, concentrated especially in the *ager* of *Dianium* and neighbouring towns (see Maps 3 and 4)<sup>46</sup>.

Most pottery workshops were located in territories with a high density of rural habitat and close to towns. The reasons for this are obvious: to ensure access to raw materials and the communications network in order to simultaneously meet rural, urban and overseas demand. Nevertheless, the way this artisan activity spread and the special characteristics it took on need to be understood in the wider context of the historical transformation of the provinces in the Western Mediterranean. Not only do we have the development of a sociocultural situation with associated forms of consumption generated by the urban lifestyle disseminated by Rome, we also have the establishment of economic structures that included specific ways of managing and organizing production and involved a complementary structural relationship between agriculture, the artisan sector and circuits of exchange in a free-market context.

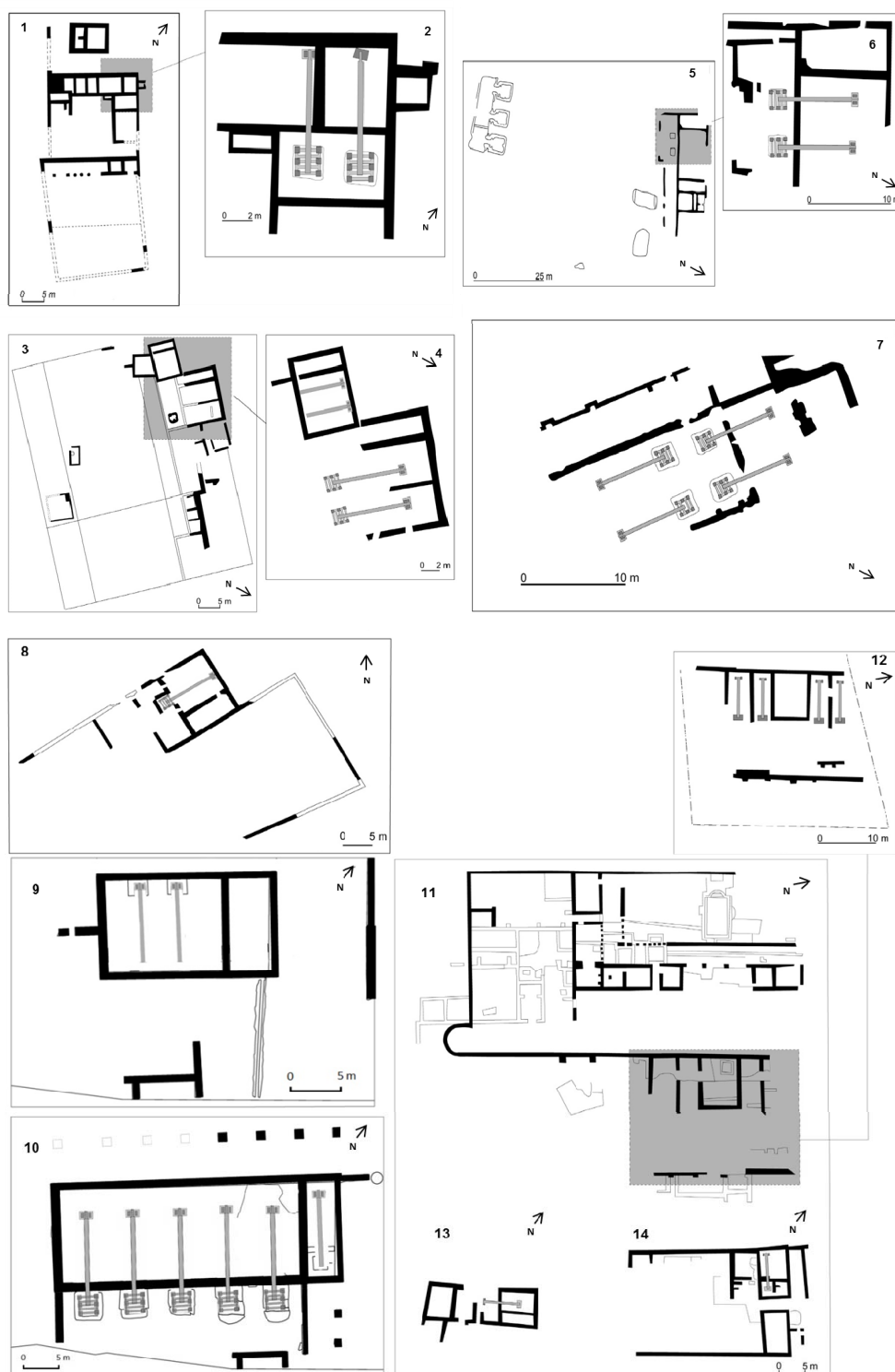
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<sup>43</sup> REVILLA, *Viticultura*, p. 87.

<sup>44</sup> Some examples: J. BURCH *et al.* *El fundus de Turissa entre el segle I aC i l'I dC. Arqueologia de dos establiments rurals. Mas Carbotí i Ses Alzines*, Girona, Universitat de Girona, 2005; REVILLA, *Hàbitat rural y territorio*, pp. 36-37.

<sup>45</sup> Catalogues: PASCUAL *Índex*; MIRÓ, *Producción de ánforas*, pp. 210-226; REVILLA, *Producción cerámica*, pp. 161-286; TREMOLEDA, *Industria cerámica*; organización del trabajo y la gestión de la actividad en: REVILLA, *Producción cerámica*, pp. 104-113; REVILLA, *Ánforas y epigrafía*, pp. 185-188; TREMOLEDA, *Instal·lacions productives*, pp. 113-150.

<sup>46</sup> GISBERT, *Àmfores i vi*, pp.383-412; GISBERT, *Vi tarraconense*, pp.125-150.



**Fig. 2. Wine pressing facilities (*Torcularia*) from Laetanian region and surroundings: 1 & 2. El Moré (Sant Pol de Mar, Maresme, Barcelona). 3 & 4. Veral de Vallmora (Teià, Maresme, Barcelona). 5 & 6. Can Feu (Sant Quirze del Vallès, Vallès Occidental, Barcelona). 7. Can Pedrerol de Baix (Castellbisbal, Vallès Occidental, Barcelona). 8. Torrebonica (Terrassa, Vallès Occidental, Barcelona). 9. Pont del Treball Digne Roman Villa (La Sagrera, Barcelona, Barcelonès), beginning 1st century AD. 10. Pont del Treball Digne Roman Villa (La Sagrera, Barcelona, Barcelonès), beginning 2nd century AD. 11. General view of *Felix Turissa* - Els Ametllers Roman Villa (Tossa de Mar, la Selva, Girona). 12. *Felix Turissa* - Els Ametllers Roman Villa (Tossa de Mar, la Selva, Girona). 13 & 14. Ses Alzines and Mas Carbotí, secondary settlements of *Felix Turissa* - Els Ametllers Roman Villa (Tossa de Mar, la Selva, Girona). Image editors: M. Cubero & A. Martín i Oliveras.**



The vast majority of the pottery workshops seem to be integrated into the organization of a *fundus*. Specifically, the production of amphorae should be understood as a complementary activity that met the needs of a semi-specialized agricultural sector that was geared to commercializing a surplus. In this context the pottery workshop first and foremost answered the *instrumentum* needs of an estate. It would therefore be a subordinate activity. But this is only a partial explanation. Not only roman treatises on agriculture but also legislation show that a *fundus* could be involved in a number of very different economic activities and that these activities were organized on various scales and with varying degrees of autonomy in relation to agriculture. An extreme case would be activities involving the mining and exploitation of natural resources and the artisan sector dedicated to satisfying nearby urban demand. The options chosen in each case were the result of a combination of the owner's interests and the natural resources locally available. Thus in the case of the manufacture of ceramics, the intention was probably to achieve the dual objective of estate self-sufficiency and sale to meet local or regional demand<sup>47</sup>.

The pottery workshops on the coast of *Citerior* were making a wide range of *amphorae* for over three centuries, although most of them were in the form of the Pascual 1 and the Dressel 2-4<sup>48</sup>. The two forms are intermixed for a number of decades around the change of era, until the Dressel 2-4 became the preferred container for exporting wine from *Citerior* in the first third of the 1st century AD<sup>49</sup>. The choice, coexistence and substitution of one amphora type by another, along with the production of less popular forms, seems to be the result of various factors acting together.

The transformation of the markets and the circuits of commercialization (with the appearance of new producers in the vicinity, in turn associated with a change in demand and tastes), no doubt brought about changes in the production structures of each territory in quantitative terms and the appearance of new qualities of wine. Although local peculiarities are difficult to appreciate in the area of production, the reorientation of the markets seems clear. While Gaul and the *Limes Germanicus* were the main consumers of wine from *Citerior* during the Augustan period, in the first half of the 1st century AD Italy, and especially the city of Rome, became the new priority destination<sup>50</sup>. Some indications suggest that, in this context, there was a change in the forms of artisan production in some territories such as Laetanian region. Specifically, factors such as the adoption of specific models in production capacity, the standardization of the Dressel 2-4 form and the complexity of

<sup>47</sup> REVILLA, *Producción cerámica*, pp. 122-124; REVILLA, *Ánforas y epigrafía*, pp. 166-167.

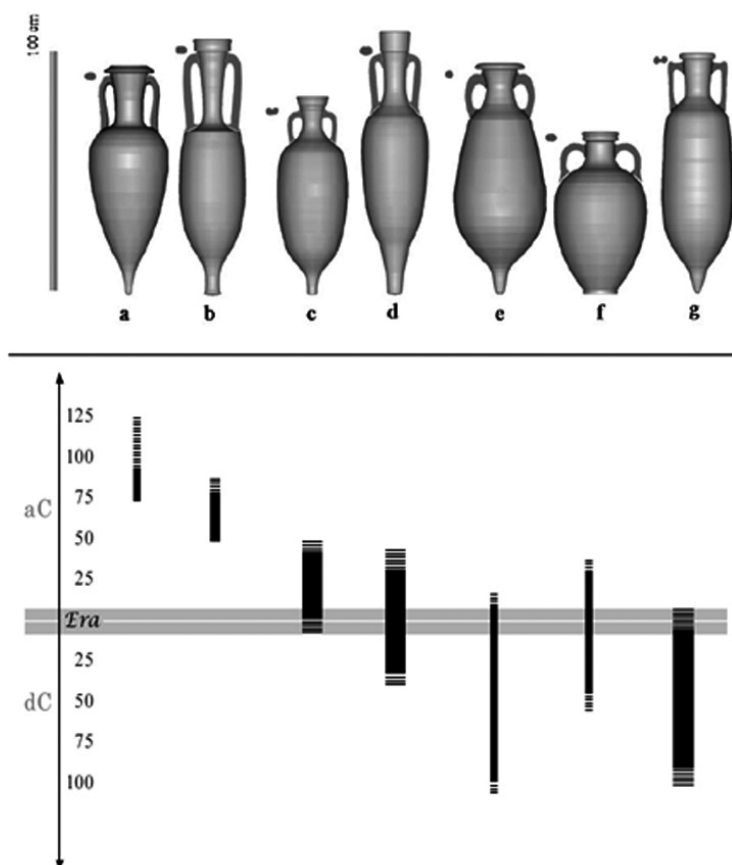
<sup>48</sup> REVILLA, *Producción cerámica*, pp. 41-43; GISBERT, *Vi tarraconense*, pp. 132-135; Pascual 1 and Dressel 2-4 amphora types were reproduced in Ibiza: RAMON, *Àmfores altimperials*, pp. 257-266.

<sup>49</sup> Other amphora types were produced during the 2nd and 3rd centuries AD, such as the Gauloise 4, but they seem to have been used for trade in low quantity; Dressel 2-4 form was still produced until the 3rd century AD: R. JÁRREGA & P. OTIÑA, 'Un tipo de ánfora Tarraconense de época medioimperial (siglos II-III): la Dressel 2-4 evolucionada', in *SFECAG, Actes du Congrès de L'Escala-Empúries*, 2008, Marseille, 2008, pp. 281-286; other amphora types were still produced during the 4th and 5th centuries AD in this region and Ibiza: J. A. REMOLÀ, *Las ánforas tardo-antiguas en Tarraco* (Hispania Tarraconensis), Barcelona, Publicacions de la Universitat de Barcelona, 2000, p. 196; RAMON, *Cerámica ebusitana*, pp. 566 and 574, figs. 1 and 7.

<sup>50</sup> MIRÓ, *Producción de ánforas*, pp. 189-203; CORSI-SCIALLANO & LIOU, *Épaves*, p. 172. New Italian markets and the technological improvements seem related to changes in the bottling and dispatch of wine during the central decades of the 1st century AD. Particularly, the introduction of 'tankers ships' with large *dolia*, allowing an increasing volume of wine being transported. This denotes a change in demand and a different method of production and commercialisation in bulk or perhaps similar to a maquila system; this would reduce the amount of transported *amphorae* considerably: CORSI-SCIALLANO & LIOU, *Épaves*; P. DELL'AMICO & F. PALLARÉS, 'Il relitto di Diano Marina e le navi a 'dolia': nuove considerazioni', in A. CORTIS & T. GAMBIN (ed.), *De Triremibus. Festschrift in honour of Joseph Muscat*, Malta, PEG Publications, 2005, pp. 67-114; P. DELL'AMICO & F. PALLARÉS, 'Appunti sui relitti a *dolia*', *Archaeologia Maritima Mediterranea*, 8, 2011, pp. 47-135; see also "Dossier les épaves à *dolia*", *Archaeonautica*, 15, 2008.



the onomastic representation used on the seal-stamps seem to indicate the existence of larger-scale, more systematized work processes within production structures of greater organizational complexity. Added to this is the possibility of other types of container (*dolia*, *cullei*, *cupae*)<sup>51</sup>.



**Fig. 3. Amphorae types documented in *regio Laetana* (1st BC to 1st AD):**

a. Greco-italic; b. Dressel 1 Citerior (A,B,C); c. Laetanian/Tarraconense 1; Pascual 1; Dressel 7-11; Oberaden 74; Dressel 2-4 Tarraconensis (according to Ll. Vila-Socias, *Una arqueometria del canvi tecnològic: Producció, i consum d'àmfores durant el canvi d'era en la zona nord de la costa catalana*, Universitat de Barcelona, 2011, p.122, fig.6.

Amphorae accounted for most production in many pottery workshops in their initial phases (Augustan and Julio-Claudian periods), but common ceramics and building materials were also made<sup>52</sup>. Between the second half of the 1st and the beginning of the 2nd centuries AD, some of them seem to reorient their activity and concentrate on manufacturing common ceramics, cookware, building materials and other specific products such as imitation African ceramic cookware and *terra sigillata*, apparently in small quantities<sup>53</sup>. For now, the latest traces of activity for some pottery workshops reach only as far as the 3rd century AD<sup>54</sup>. These changes in the range of products made and manufacturing methods, with slight variations depending on the territory, could be due to a restructuring of artisan activity, which in many cases would become an autonomous sector within the organization of a *fundus* to cover local or regional demand.

<sup>51</sup> Standardization: CORSI-SCIALLANO & LIU, *Épaves*, p. 168; organizative complexity: REVILLA, *Onomástica*, pp. 1183-1192; productive role: MARTÍN i OLIVERAS, *Arqueología del vi*, pp. 203-207.

<sup>52</sup> The amphorae were the 85% of the local ceramic produced in the *figlinae* from the territory of *Dianium*: GIBERT, *Àmfores i vi*, p. 389.

<sup>53</sup> REVILLA, *Producción cerámica*, p. 83.

<sup>54</sup> TREMOLEDA, *Instal·lacions productives*, p. 135.

The limited corpus of amphora inscriptions and especially seal-stamps also make it possible to analyse the organization of the artisan pottery and winegrowing processes<sup>55</sup>. However, this corpus presents some serious problems. First, the content is almost exclusively onomastic and difficult to interpret. These forms indicate different legal and social situations, and different relationships between the artisan sector and agricultural production. In only a few cases does the identification of certain people as members of the elites enable us to consider questions about ownership of the land, the pottery activity, the packaged product and the underlying interests and strategies. Second, generally speaking these are very simple epigraphs (often just capital letters), and this gives rise to problems of homonymy and identification. Finally, the corpus of seal-stamps collected is very small, comprising only a few hundred. Also, the habit of sealing *amphorae* seems to be very limited in both frequency (only a small proportion are sealed) and in terms of chronology and geography (most seal-stamps are essentially from the Julio-Claudian and Flavian periods and come from pottery workshops on the Barcelona coastline)<sup>56</sup>.

As a rule the seal-stamps are made up of capital letters identified as the possible initials of a name or groups of letters forming a *cognomen*. As regards what they mean, there are various interpretations. One suggestion is that these seal-stamps may be exclusively linked to the business of pottery production and would correspond to individuals of a modest social position carrying out specific roles within the artisanal *amphorae* production process. Some could be identified as simple workers, while others would have greater responsibility as skilled workers or workgroup leaders. In any event, the presence of these seal-stamps and in particular the existence of 2 or 3 grouped together on the same amphora gives the impression of a well-defined rigorous organization of artisan work that would coincide with the standardized manufacture of the Dressel 2-4 Tarrakonense amphora<sup>57</sup>. Other hypotheses link part of this epigraphy to the owners of the *figlinae* and to the contents, also representing the producer and/or the owner of the *fundus*<sup>58</sup>.

A study of other forms of onomastic representation with *duo nomina* comprising *praenomen-nomen* or *nomen-cognomen*, or *tria nomina*, supplies an important piece of information: that the elites had direct interests in the region's viticulture. It is difficult to define the exact value and organization of these interests, i.e. whether they were limited to land ownership or whether they stretched as far as artisan activity, the exploitation of natural resources and trade through representatives. Naturally it is also very difficult to establish what proportion of an elite family's wealth these interests represented. At least it has been possible to identify very different people and social situations: senatorial families<sup>59</sup>,

<sup>55</sup> REVILLA, *Producción cerámica*, pp. 104-105; REVILLA, *Ánforas y epigrafía*, pp. 169-172 and 195.

<sup>56</sup> MIRÓ, *Producción de ánforas*, pp. 210-226; PASCUAL, *Índex*, 6-8.

<sup>57</sup> CORSI-SCIALLANO & LIU, *Épaves*, p. 165; REVILLA, *Onomástica*, pp. 1189-1191; BERNI & REVILLA, *Sellos*, pp. 95-111; P. BERNI & R. JÁRREGA, 'Exportación e importación de ánforas en el *ager Tarrakonensis* entre finales de la República y el Alto Imperio', in V. MARTÍNEZ FERRERAS (ed.) *La difusión Comercial de las Ánforas Vinarias de Hispania Citerior Tarrakonensis (s.I aC-I dC)*, Oxford, Archaeopress, 2015, pp. 79 -90; C. CARRERAS, 'Novedades en torno a la producción y distribución de las ánforas del *ager Barcinonensis* (El Baix Llobregat)', in V. MARTÍNEZ FERRERAS (ed.) *La difusión Comercial de las Ánforas Vinarias de Hispania Citerior Tarrakonensis (s.I aC-I dC)*, Oxford, Archaeopress, 2015, pp. 67-78.

<sup>58</sup> A. LÓPEZ MULLOR, 'El centre productor d'àmfores de Sant Boi de Llobregat (Barcelona)', in *Actes del II Col·loqui Internacional d'Arqueologia Romana. El Vi a l'Antiguitat. Economia, Producció i Comerç al Mediterrani occidental*, (Badalona, 1998), Badalona, Museu de Badalona, 1998, p. 235; A. MARTÍN MENÉNDEZ, 'Consideraciones sobre las marcas de ánforas tarrakonenses en la Layetania septentrional. Los casos de El Mugal-El Roser (Calella) y Can Rodón y Ca l'Arnau (Cabrera de Mar)', in V. MARTÍNEZ FERRERAS (ed.) *La difusión Comercial de las Ánforas Vinarias de Hispania Citerior Tarrakonensis (s.I aC-I dC)*, Oxford, Archaeopress, 2015, pp. 39-54.

<sup>59</sup> P. GIANFROTTA, 'Lentulo Augure e le anfore laietane', in *Epigrafia ed ordine senatorio, Tituli*, 4, Roma, 1982, pp. 475-479.

*equites* from the north of Italy<sup>60</sup>, provincial aristocracy<sup>61</sup> and families from *Barcino* and *Tarraco*<sup>62</sup>. However, the origin and geographic location of these individuals' properties pose another problem. In only a few cases do these people seem to be connected to the big wine-producing establishments on the coast between *Barcino* and *Emporiae*, always dated to the Julio-Claudian, Flavian and, to a lesser extent, Antonine periods. The development of this viticulture must also have contributed to a proliferation of small and medium-sized owners who would have sold their production to independent traders or big landowners' commercial agents. For the present, however, we have insufficient data on the subject.

Some of the profits obtained from these activities may have enabled certain individuals and collectives to rise in legal and social terms. There is some evidence to suggest that a number of slaves responsible for management processes in agriculture and/or the artisan sector managed to obtain their freedom and rise socially. The significance of this phenomenon can be appreciated in the importance of freedmen in cities like *Barcino* and *Dertosa*<sup>63</sup>. In short, therefore, the spread of viticulture and the wine trade may have contributed to the region's socioeconomic development. However, there is not enough documentary evidence to allow an accurate assessment of viticulture's position relative to other activities and its weight in the province's economy as a whole.

#### VITICULTURE IN HISPANIA ULTERIOR BAETICA

The literary testimonies about Baetican wine are concentrated in the 1st century AD. Strabo (III, 2, 6), the first to mention it, describes the abundance of exports that may have benefited from the trade of other products such as grain and oil. His testimony summarizes the geography of consumption (cf. his reference to the ships from Turdetania that would arrive in *Puteoli* and *Ostia*) and the commercial traffic that "very nearly rivals that of the Libyan ships". Columella (*De R. R.*, I, pref., 20), for his part, points out that products from the Cyclades and the regions of Baetica and Gaul were stored in Lazio. Testimonies like these show that exporting was a consolidated activity with Lazio and Campania as destinations, and that it was carried out in competition with other parts of the Empire. The perception of how important certain areas of Baetica were seems to be implied by the use of the term "regions", e.g. "...ac regionibus Baeticis Gallicisque", which suggests the existence of different production situations within the province. Because of Columella's family connections with *Gades*, the news he provides forces us to question the appropriateness of his advice about agriculture as regards the real situation in *Baetica*<sup>64</sup>. Other sources are markedly aesthetic in character and their references are difficult to evaluate as contemporary testimony<sup>65</sup>. Silius Italicus (*Pun.*, III, 393), for

<sup>60</sup> J. TREMOLEDA, 'Un nou inversor en la viticultura de la *Tarraconensis*: Publi Baebi Tuticà', *Pyrenae*, vol. 36, num. 2, 2005, pp. 115-140.

<sup>61</sup> J. TREMOLEDA, 'Pvblivs Vsvlenvs Veiento. Un magistrat narbonès amb propietats al nord de la *Tarraconense*', in *XI Col.loqui Internacional d'Arqueologia, Comerç i vies de comunicació (1000 aC-700 dC)*, Puigcerdà, 1997, Puigcerdà, Institut d'Estudis Ceretans, 1998, pp. 231-241; M. CHRISTOL & R. PLANA, 'De la Catalogne à Narbonne: épigraphie amphorique et épigraphie lapidaire, les affaires de Veiento', in G. Paci (ed.), *Epigrafia romana in area Adriatica, IX Rencontre franco-italienne sur l'épigraphie du monde romain*, Macerata, 10-11 nov. 1995, Pisa-roma, École Française de Rome, 1998, pp. 273-302.

<sup>62</sup> RODÀ; MARTÍN i OLIVERAS *et al.*, *Personatges de Barcino*, pp. 47-57; OLESTI, *Propiedad de la tierra*, pp. 175-200; OLESTI, *Propiedad i riquesa*, pp. 141-158; P. BERNI, 'Epigrafia sobre *amphorae*, *tegulae*, *imbrex* i *dolia* a l'àrea occidental del Camp de Tarragona', in D. Goróstidi (ed.), *Ager Tarraconensis 3. Les inscripcions romanes*, Tarragona, Institut Català d'Arqueologia Clàssica, 2010, 153-210; I. CABRELLES, 'Elits ciutadanes i propietat rural durant l'Alt Imperi. El cas del Clodii de Tàrraco', *Pyrenae*, vol. 44, num. 2, 2013, pp. 7-23; see also: M. J. PENA & A. BARREDA, 'Productores de vino del nordeste de la *Tarraconense*. Estudio de algunos nomina sobre ánforas Laietana 1 (=Tarraconense 1)', *Faventia*, vol. 19, num. 2, 1997, pp. 51-73.

<sup>63</sup> Dossier on epigraphic evidence and prosopography in: OLESTI & CARRERAS, *Esclavos y libertos*, 309-333; see also: PONS, *Consideraciones teóricas*, pp. 215-219.

<sup>64</sup> SÁEZ, *Vino en la Bética*, p. 19; ÉTIENNE & MAYET, *Vin hispanique*, pp. 68-70; PEÑA, *Torcularia*, p. 172.

<sup>65</sup> See comments in Section 2.

example, provides a literary image when he relates the name of *Nabrissa* - today Lebrija, on the coastline of the former *lacus Ligustinus*, today the Doñana Marshlands - with the cult of *Bacchus*.

The scarcity of sources has directed the research towards an exhaustive examination of texts and a search for complementary information. In this regard, scholars have explored the possibilities offered by civic coinages from the Republican and Augustan periods, with representations of vine tendrils and bunches of grapes or the god *Bacchus*. However, these representations must be understood primarily as images of prestige and identity used by certain cities. They are not direct evidence that viticulture was their main agricultural activity<sup>66</sup>. More important are the contributions of archaeology, which have made it possible to locate and date the introduction of technology and production processes<sup>67</sup>. The evidence is scarce but significant, such as the *torcularium* from Loma de Ceres (Map 5, N° 35)<sup>68</sup>. Finally, the research has also resorted to comparing the philological-archaeological data with information from former regions of production and today's designations of origin<sup>69</sup>.

As with other regions, the study of Baetic viticulture is based on determining the types of amphorae used and analysing the *figlinae*. So far 8 types of amphorae have been identified in connection with the transporting of wine and grape-based products such as *sapa* and *defrutum*<sup>70</sup>. In the case of two of these amphorae, the Haltern 70 and the Dressel 2-4, different areas of production have been identified: the coast of *Baetica* (C.B.) and the valley of the Guadalquivir (V.G.). The chronology and geographic distribution of Baetic products – although with serious problems as regards certain forms – have been summarized as far as possible in Table 1.

The table shows initial and final datings for the production and general distribution of each amphora and for its specific manufacture in Baetica<sup>71</sup>. In the case of the Dressel 2-4, the chronological comparison falls within the wider framework of Italic productions. In the case of the Haltern 70 and its later variant, the Verulamium 1908, the chronologies of these types of production from Lusitania and Gaul are also considered. Some forms, such as the Dressel 30 and the Gauloise 4, pose particular problems when it comes to dating the initial and final times of production. Some of the Baetic amphorae can also be considered bivalent, especially those produced on the coast. They would have been destined mainly for salted products and fish sauces, although that does not exclude the possibility that they may have occasionally been used for exporting a significant volume of grape-based products<sup>72</sup>.

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<sup>66</sup> SÁEZ, *Vino en la Bética*, p. 16; ÉTIENNE & MAYET, *Vin hispanique*, 2000, pp. 61-66; C. CARRERAS, 'Geografía de la producció de les Haltern 70', in *Culip VIII I le àmfores Haltern 70*, Girona, Museu d'Arqueologia de Catalunya, 2004, p. 77, fig. 43; PEÑA, *Torcularia*, p. 172.

<sup>67</sup> SÁEZ, *Vino en la Bética*, pp. 25-26; A. AGUILERA, 'Defrutum, sapa y caroenum. Tres nombres y un producto: arropé', in *Culip VIII i les àmfores Haltern 70*, Girona, Museu d'Arqueologia de Catalunya, 2004, pp. 120-123; PEÑA, *Torcularia*, p. 172.

<sup>68</sup> PEÑA, *Torcularia*, pp. 171-172.

<sup>69</sup> ÉTIENNE & MAYET, *Vin hispanique*, pp. 71-72; CARRERAS, *Geografía*, p. 77, figs. 42-43; PEÑA, *Torcularia*, p. 172.

<sup>70</sup> E. GARCÍA VARGAS, 'El vino de la Bética altoimperial y las ánforas: a propósito de algunas novedades epigráficas', *Gallaecia*, vol. 23, 2004, pp. 117-134; E. GARCÍA VARGAS, 'Las ánforas del vino bético altoimperial: formas, contenidos y alfares a la luz de algunas novedades arqueológicas', in L. LAGÓSTENA & D. BERNAL (eds.), *Figlinae Baeticae: talleres alfareros y producciones cerámicas en la Bética romana (ss. II a.C.-VII d.C.): Actas del Congreso Internacional, Cádiz, 12-14 de noviembre de 2003*, Oxford, Archaeopress, 2004, pp. 507-514; E. GARCÍA VARGAS & D. BERNAL, 'Ánforas de la Bética', in D. BERNAL & A. RIBERA (eds.), *Cerámicas hispanorromanas. Un estado de la cuestión*, Cádiz, Universidad de Cádiz, 2008, pp. 661-687.

<sup>71</sup> *Roman Amphorae*: a digital resource. University of Southampton, 2005 (updated 2014), [http://archaeologydataservice.ac.uk/archives/view/amphora\\_ahrb\\_2005/cat\\_amph.cfm](http://archaeologydataservice.ac.uk/archives/view/amphora_ahrb_2005/cat_amph.cfm), [13/11/2015]; *Amphorae ex Hispania*. "Paisajes de producción y consumo", <http://amphorae.icac.cat/>, [13/11/2015].

<sup>72</sup> A similar consideration for Dressel 7-11 types from *Citerior*, particularly for Dressel 8 "emporitana" in: MIRÓ, *Producción de ánforas*, p. 103; LÓPEZ MULLOR & MARTÍN MENÉNDEZ, *Tipología*, pp. 76-79.

FORM	INITIAL	INITIAL BAETICA	FINAL BAETICA	FINAL	FIGLINAE
Haltern 70 (B.C.)	80 BC	50 BC	75 AD	192 AD	24-29,31-32
Haltern 70 (G.V.)	80 BC	50 BC	90 AD	192 AD	1-23
Urceus (G.V.)		25 BC	50 AD		
Dressel. 2-4 (B.C.)	70 BC (Dr. 2-4 Italian)	25 BC	125/150 AD	Beginning 3rd century AD (Dr. 2-4 Italian)	30-31, 34
Dressel 2-4 (G.V.)	70 BC (Dr. 2-4 Italian)	1 AD	100 AD	Beginning 3rd century AD (Dr. 2-4 Italian)	2-3
Dressel 28 (G.V.)	Late Augustan	1 AD	150 AD	150 AD	6, 21-22
Verulamium 1908 (G.V.)	circa 30 AD	40 AD	100 AD	160 AD	10?
Dressel 30 (B.C.)	201 AD	150/175 AD	450 AD	400 AD	33, 35-36
Gauloise 4 (B.C.)	50 AD	175 AD	350 AD	299 AD	27, 35-37
Matagallares I (B.C.)		175 AD	350 AD		36

**Table 1. General and specific chronologies for the Baetican amphorae forms (INITIAL, FINAL) and geographical distribution of *figlinae* (Baetican coast: B.C and Guadalquivir Valley: G.V.) related with Baetican amphorae output for grape by-products. Data composition: D. Martín-Arroyo 2016.**

When studying Baetican *amphorae*, the analysis of typological details also poses problems. For example, because of its similar shape it can be difficult to distinguish the coastal production of the Haltern 70, the most common container for these types of export, from the Dressel 7-11 group, very common in what is today the province of Cádiz<sup>73</sup>. This problem does not arise in the Guadalquivir valley, since the difference in shape between the Haltern 70 *amphorae* and oil *amphorae* is more obvious.

One of the difficulties when studying amphorae from this area is the combination of a lack of excavations and the continued artisan activity in many places over various centuries. This continuity hinders identification of the production phases of the Haltern 70 that have been buried under the accumulated waste from the Dressel 20 amphorae corresponding to later phases of activity which, in addition, seem to correspond to production situations organized on a larger scale<sup>74</sup>. Added to this is the fact that oil amphorae and their epigraphy have attracted more interest in recent years, relegating the identification of other types of amphora to a secondary plane. In both the coastal area and the Guadalquivir valley the manufacture of wine amphorae seems to occupy less space in pottery workshop activity, although the situation varies from area to area. Hence the limited presence of wine compared to oil amphorae seems obvious away from the sea. The difference is less disproportionate in the case of amphorae for salted products from the coast, although the subject needs to be examined in depth. This disparity makes it necessary to consider another problem: the assessment of the value of the wine economy in relation to other products exported on a large scale which have traditionally been considered the main resource and driving power of the Baetic economy, namely oil and salted products.

The initial point for Baetic exports depends on our identifying the exact contents of certain amphorae imitated in the region. It is known that there was local production of Greco-Italic with ancient chronologies (250~150/125 B.C.), manufactured exclusively on the coast, and Dressel 1 from the coast (140/130~30/25 B.C.) and inland (110/90~35/25 B.C.). One particular problem area

<sup>73</sup> Torre de los Herberos (n. 23) and coast sites in the maps are taken from CARRERAS, Geografía, p. 76, fig. 42. It is likely than more Haltern 70 *figlinae* could be located along the ancient southern shore of the *lacus Ligustinus*.

<sup>74</sup> Inland sites in maps are taken from P. BERNI, 'Tipología de la Haltern 70 bética', in C. CARRERAS, R. MORAIS & E. GONZÁLEZ FERNÁNDEZ (coords.), *Ánforas romanas de Lugo*, Santiago de Compostela, Universidad de Santiago de Compostela, 2011, p. 105, fig. 12. On the Haltern 70 finds, see BERNI, Tipología, pp. 98-99. We are grateful for the Juan Moros Díaz's advice on the accurate location of these sites.



involves amphorae that still existed at the beginning of the Early Empire period, as in the case of the Ramon T. 7-7433 (*Ca.* 150 B.C./A.D. 140~1) shape, manufactured on the coast. Away from the coast the Ovoid 1, 4, 5 and 6 *amphorae*, with a chronology centred around 70 and 15 B.C., would be in a similar situation.

The export of grape by-products from the Guadalquivir valley would cease at the end of the 1st century AD, although it appears that shapes like the Dressel 28 continued to be made. Continuity in the manufacture of the Dressel 30, Gauloise 4 and Matagallares I shapes enables confirmation of the continued existence of a coastal viticulture with export capacity. And bearing in mind the hypothesis regarding their bivalence, the chronology of the Beltran IIA (*ca.* 15/25 ~ 150) and IIB (50 ~ 225) salted fish *amphorae* could let it be argued that a certain volume of exports was maintained. Other containers, such as barrels, could also have been used<sup>75</sup>.

In marked contrast to the situation involving the Dressel 20, for example, the epigraphy of Baetic wine amphorae is scarce. The evidence is concentrated mainly on Haltern 70 amphorae from the Guadalquivir valley. No inscriptions have been found on Urceus, Dressel 30, Gauloise 4, Matagallares I or Haltern 70 type amphorae from the coast of *Baetica*. As regards Dressel 2-4 from the coast, two seal-stamps from the Villa Victoria *figlina* (Map 5, N° 31) have been identified, consisting of a simple circle between the rim and the neck. However, the seal-stamp L·VALE[RI]·AMETHYSTI has been found at the Dehesa de Arriba (Map 5, N° 2) site in the Guadalquivir valley. Epigraphy involving the Dressel 28 is also very scarce, with seal-stamps such as CASSIOR\* and |CELTVS|/V'O'K'·FEC|<sup>76</sup> being the main examples. The *tituli picti* on these amphorae include numerals and the names of traders<sup>77</sup>. Outstanding among these is *Aulus Atinius*, which is also documented on *amphorae* for salted products. This coexistence is not surprising, since we know about the manufacture and commercialization of salted products from the lower course of the *Betis*, upstream from the *lacus Ligustinus*<sup>78</sup>. As for the Verulamium 1908, the seal-stamps |LI·FO| and |L·I·F·O| have been found, the first of these being located on the handle<sup>79</sup>.

In the case of the Haltern 70 amphora, the CEIPAC database includes a total of 77 objects which, in some cases, have a combination of stamps, *tituli picti* and graffiti. The corpus is listed as 13 seal-stamps, 27 *tituli* and 34 graffiti. The epigraphy of these amphorae has been catalogued and studied in great detail<sup>80</sup>. These containers were produced and commercialized alongside the Dressel 20 oil amphora, as shown by stamped epigraphy and known graffiti. The written inscriptions show that the Haltern 70 were used to transport *muria* and olives, the latter occasionally *ex defrutum*. This preservative, also identified on the amphorae as *sapa*, consisted of a syrup made from must reduction<sup>81</sup>.

<sup>75</sup> ÉTIENNE & MAYET, *Vin Hispanique*, pp. 21-58.

<sup>76</sup> Corpus CEIPAC, <http://ceipac.gh.ub.es/>, [13/11/2015]: 6061 and 15074.

<sup>77</sup> Corpus CEIPAC, <http://ceipac.gh.ub.es/>, [13/11/2015]: 21452 and 33425.

<sup>78</sup> E. GARCÍA VARGAS, 'Una factoría altoimperial de salazones en *Hispalis* (Sevilla, España)', in D. BERNAL & L. LAGÓSTENA (eds.) *Figlinae Baeticae. Talleres alfareros y producciones cerámicas en la Bética romana (ss. II a.C. – VII d.C.): Actas del Congreso Internacional (Cádiz, 12-14 de noviembre de 2003)*, Oxford, Archaeopress, 2004, pp. 335-339.

<sup>79</sup> Corpus CEIPAC, <http://ceipac.gh.ub.es/>, [13/11/2015]: 07870 and 25022.

<sup>80</sup> J. MOROS & P. BERNI, 'Catálogo de sellos', in *Culip VIII i les àmfores Haltern 70*, Girona, Museu d'Arqueologia de Catalunya, 2004, pp. 51-57; A. AGUILERA, 'Los *tituli picti*', in *Culip VIII I les àmfores Haltern 70*, Girona, Museu d'Arqueologia de Catalunya, 2004, pp. 57-69.

<sup>81</sup> A. AGUILERA, 'El contenido de las Haltern 70 según los *tituli picti*', in *Culip VIII i les àmfores Haltern 70*, pp. 119-120; AGUILERA, *Defrutum*, pp. 120-132.

A case study is a quantitative and/or qualitative method of research widely used in both the experimental sciences and the social sciences and humanities. It is also used in history and Archaeology to gain a detailed understanding of the transformation of a cultural landscape over time, or to understand the evolution of a social or economic phenomenon that took place in the past. The most typical feature of this method is an intensive, in-depth knowledge of one or more cases, faced with a situation or process of historical importance, this being understood as a system “restricted” by the limits dictated by the object of study itself, but framed within the global context in which this phenomenon comes about.

With the two studies chosen for this paper, the intention is to increase our knowledge of the origin, development and evolution of intensive vitivinicultural production during the Roman Late Republic and Early Empire in two very different territories: the *regio Laeetana* in *Hispania Citerior Tarraconensis* and the *confinium* of *Hasta Regia-Gades* in *Hispania Ulterior Baetica*. In both cases the aim is to obtain greater knowledge by applying different study techniques and models to enable us to analyse the evolution of this historical phenomenon from a diachronic point of view in each territorial context. Afterwards we will apply all this knowledge in our study of the social space in which this ancient economic phenomenon occurred.

### 5.1. Regio Laetana: economic, econometric and predictive/regressive/ reconstructive models

Intensive viticulture during Roman times in the north-east of the Iberian Peninsula was a far-reaching phenomenon with important economic implications which constituted a true sociocultural revolution for this territory at all levels.

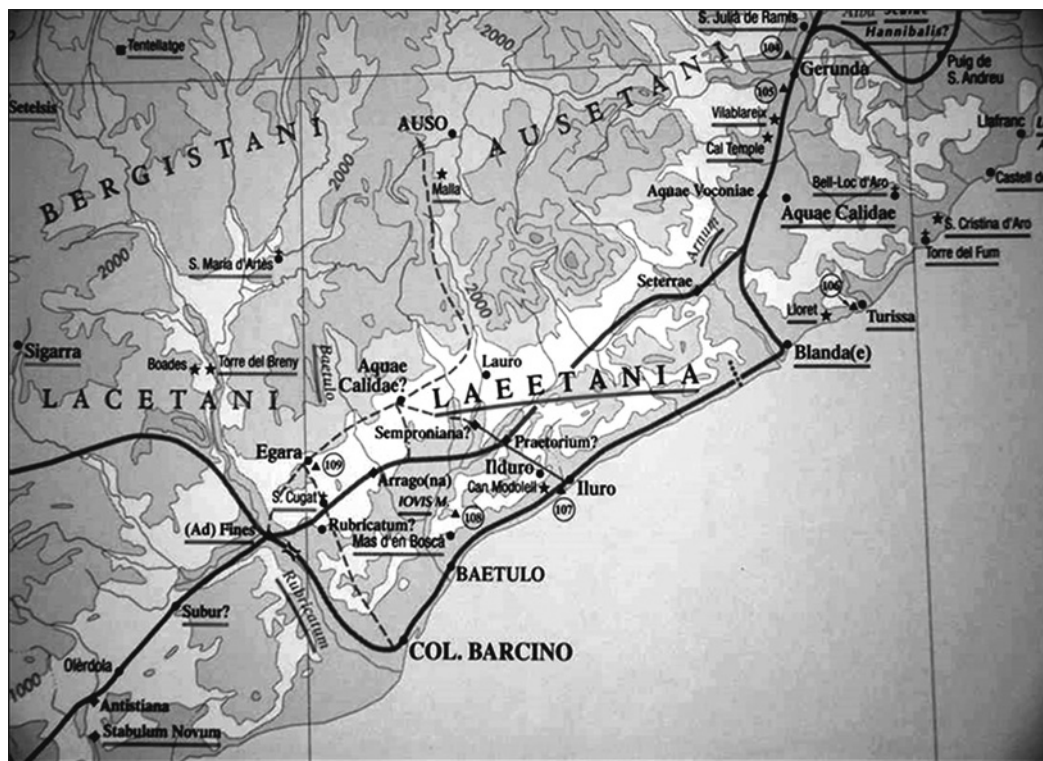


Fig. 4. The *regio Laeetana* with its Latin toponymical items and main roads (1st. century BC to 3rd. century AD).

## ***Territorial scope***

Laetanian region is an ill-defined area in historical terms that includes, among other things, the *oppidum* of *Blanda* or *Blandae*, the *municipia* of *Iluro* and *Baetulo* and the *colonia* of *Barcino*. The extension and limits of these cities' territories have not been precisely defined with the exception of the *ager Barcinonensis*, the constitution and legal status of which must have had an effect on the urban centres that were there before. The territory comprised the extensive plain situated between the course of the river Besós and the mouth of the *Rubricatum* (Llobregat), located on the other side of the Montjuïc promontory. The first foothills of the Garraf Massif would have risen from this point. Away from the coast the colony's *ager* would have included the lower course of the Llobregat as far as *Ad fines* (Martorell) and the lower course of the Besós to where it joined the river Ripoll and the Congost-Mogent basin, spreading across the great Vallès plain as far as the Catalan Pre-Coastal Range.

## ***Work hypothesis***

The studies of amphorae carried out in recent decades and the suggestions put forward regarding how to interpret them make it possible to propose a chronocultural-evolutionary sequence of vitiviniculture in this territory, from both a production and a trade perspective. We start with the premise that there are five main chronocultural phases of development, which we consider correspond to the configuration of different agricultural and artisan production systems<sup>82</sup>:

- *Phase 1. Origins (½ 2nd C-½ 1st C BC)*: First productions with Italic-imitation Greco-Italic and Dressel 1A, 1B and 1C *Citerior* types amphoric containers.

- *Phase 2. Expansion (½ 1st C BC-middle decades of 1st C AD)*: Appearance of the first widely-manufactured amphorae forms: *Tarraconense* 1/Layetana 1 and Pascual 1, the latter being the first *Tarraconense* amphora intended for large scale trade. Appearance of first imitations of the Dressel 2-4 italic form.

- *Phase 3. Reorientation (middle decades of 1st C AD-end of 1st C AD)*: Characterized by large-scale production of Dressel 2-4 *Tarraconense* amphorae form and *dolia* (big pottery jars) for the massive export of wine, both individually packaged and in bulk, mainly destined for the Italic Peninsula and the city of Rome itself.

- *Phase 4. Peak (early 2nd C AD-mid 3rd C AD)*: Period when the production structures were transformed, probably connected to the export of wine in bulk in other types of containers such as *cupae* (barrels) and *culleii* (wineskins), and possibly as a consequence of having to reduce costs when supplying heavily-used, strongly competitive markets.

- *Phase 5. Decline (½ 3rd C AD-early 5th V AD)*: Crisis and the end of viticulture for export? The phenomenon could be due to the appearance of new producers with much lower costs, which would imply a change in market orientation. The vitivinicultural centres of *Hispaniae* are restructured to carry out other agricultural activities or were gradually abandoned.

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<sup>82</sup> MARTÍN i OLIVERAS, *Arqueologia del vi*, pp. 197-207; cf. MIRÓ, *Producción de ánforas*, pp. 210-226.

## ***Object of study***

Our object of study is focused on the knowledge of the origin, development and evolution of intensive vitivinicultural production in the ancient *regio Laeetana* through the identification of different microeconomic, mesoeconomic and macroeconomic models. Using these as a starting point, our aim is to develop econometric models and specific predictive/regressive/reconstructive models to enable us to analyse the evolution of this historical phenomenon in the period from the mid-1st century BC to the mid-3rd century AD.

## ***Objectives***

- To inventory and catalogue all those archaeological sites within the territorial area of the object of study that have a presence of structures related to vitivinicultural production processes between the 1st century BC and the 3rd century AD.
- To identify possible settlement models and patterns to enable a diachronic reading of population fluctuations, the distribution and the ownership of the land and the agricultural use of the territory during the chronological period object of the study.
- To characterize a typology of paradigmatic settlements or “types”, studying their production structure and its evolution so as to establish possible economic models.
- To develop microeconomic studies of costs, margins and production prices in vitiviniculture so as to implement possible econometric models.
- To establish possible geospatial and geoeconomic study models to make it possible in the future to develop predictive/regressive economic and econometric models, capable of being applied diachronically to any agricultural or artisan activity in ancient times.

## ***Methodology***

From a methodological and conceptual point of view, we distinguish between three levels of knowledge:

### a) In-depth study of the written sources (primary and secondary):

- Agronomists and other authors (Cato, Varro, Columella, Palladius and Pliny the Elder) who describe aspects related to production and commercialization, vitivinicultural techniques, processes and procedures. Writers who give information about symbolic aspects, tastes and preferences in wine consumption in Roman times (Martial, Ovid, Horace, Juvenal, Virgil).

### b) Study of the archaeological evidence and ethnographic parallels:

- Analysis of archaeological sites and search for parallels in other sites, near and far, of similar characteristics and chronology.
- Analysis of ethnographic parallels in modern and contemporary times to provide study models and technofunctional solutions.

c) The third level of knowledge involves archaeological experimentation:

- Rigorous reproduction of the processes and the techniques concerning technological and functional procedures of vitivinicultural production in antiquity so as to prove or refute our work hypothesis.

On a territorial level we distinguish between five study types:

- *Palaeoenvironmental studies*: These correspond to the first work phase to be carried out. Sedimentological, carpological, palynological, anthracological, etc. analyses provide an important “data proxy” that enables us to make inferences about the transformation of the landscape, whether natural or anthropic, and its evolution over time.

- *Geospatial studies*: These correspond to the second work phase to be carried out and serve to identify and make known all the endogenous and exogenous variables and factors that from an archaeomorphological point of view play a part in the configuration of the system. A combination of tools will be used to implement them: geographic information systems (GIS), relational databases and statistical analysis programs. These will make it possible to model and calculate settlement patterns as regards the distribution and ownership of the land, *Ager divisus et assignatus (catastro et centuriato)*, *ager per extremitatem mensura comprehensus* and *ager arcifinalis*, and to identify and typologically characterize the various centres of production/distribution and their evolution over time<sup>83</sup>.

- *Geomorphological studies*: These enable us to model the agricultural use of the territory from a diachronic point of view as regards the analysis of the different types of terrain and soils and the configuration of the fields through the application of viticultural techniques including the different systems for propagating, training and pruning the vines.

- *Technofunctional studies*: These analyse both the production and storage structures and the technological innovations in pressing and winemaking identified for each settlement “type”.

- *Geeconomic studies and models*: These are used to calculate the yield and productivity scales in absolute terms of maximum production capacity for both the properties as a whole (*crop simulation models*, CRM) and the production and storage facilities (*yields*).

## **Modellization**

A model is any concept, relationship or object used to study and represent some part of the empirical reality simply and comprehensibly<sup>84</sup>. Therefore, in order to obtain an objective, empirical

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<sup>83</sup> Frontinus divides lands into three heads (qualitates): *Ager divisus et assignatus*; *ager mensura comprehensus* and *ager arcifinius*. *Ager divisus et assignatus* was public land that was assigned or granted to private persons by *centuriato et catastro*. The *ager mensura comprehensus* appears to signify a tract, of which the limits were defined by measurement, which was given in the mass to some community: ‘*cujus modus universus civitati est assignatus*’. The *ager arcifinius* appears to express the whole of a territory, which had only some natural or arbitrary boundary, and was not defined by measurement: ‘*qui nulla mensura continetur*’; in <http://www.thelatinlibrary.com/frontinus.html>; also see: W. SMITH D.C.L., LL.D., ‘A Dictionary of Greek and Roman Antiquities’, John Murray, London, 1875, *AGER*; *Lacus Curtius*: [http://penelope.uchicago.edu/Thayer/E/Roman/Texts/secondary/SMIGRA\\*/Ager.html](http://penelope.uchicago.edu/Thayer/E/Roman/Texts/secondary/SMIGRA*/Ager.html); and M. J. CASTILLO, *Espacio en orden: El modelo gromático romano de ordenación del territorio*, Universidad de la Rioja, 2011, pp. 83-110.

<sup>84</sup> X. RUBIO, *Modelització i simulació aplicades a la recerca i interpretació de camps de batalla*, PhD thesis, Universitat de Barcelona, 2009. <http://diposit.ub.edu/dspace/handle/2445/41457>.

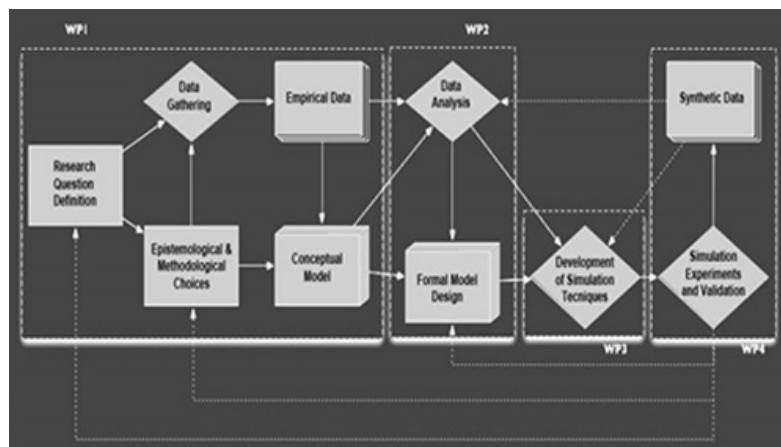


understanding of a past or present reality, study models need to be established to enable us to explain it and simulate it. On the basis of this definition and through the extensive use of mathematical and statistical models and online linear programming, we can analyse, interpret and make predictions, regressions or reconstructions about the evolution of ancient economic systems as regards the potential production of a region or territory, the production surplus that could be commercialized in foreign markets, and variables such as the selling price, market reactions, production and transport costs, business trends and the consequences of economic policy.

The following diagrams show the different stages and processes that define the cognitive process through the application of models:



They also show the different phases or stages of the research through the way these are developed and applied:



Any investigation that aims to obtain a more detailed knowledge must follow a methodology that includes developing its studies at different scales of analysis:

- *Geospatial*: At macro-spatial (*regio*), meso-spatial (*territorium*) and micro-spatial (*torcularium atque figlina*) levels.
- *Goeconomic*: At macro-economic (*regio*), meso-economic (*territorium*) and micro-economic (*torcularium atque figlina*) levels.

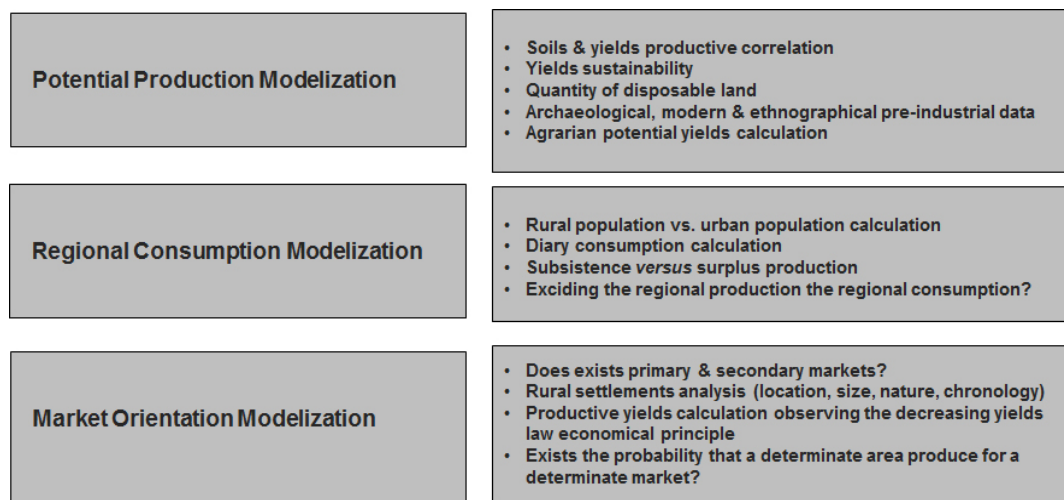
As far as the origin, development and spread of vitiviniculture in the *regio Laetana* between the 1st century BC and 3rd century AD is concerned, an important catalyst seems to have been the territorial and demographic configurations themselves and the specific interaction between these two variables and the intra-regional and extra-regional economic networks. This interaction comes about due to a series of behaviours and decision-making processes that can be studied and modelled. There are three modelling categories:

- *Descriptive models*: These quantify the interrelations of the data in order to group them and classify them in sets, e.g. economic and econometric models developed through the adoption of geospatial and geoeconomic quantification processes, adapted to a past reality<sup>85</sup>.

- *Decision-making models*: These describe decisions in connection with all the elements, variables and agents that play a part in the process. They serve to predict possible results depending on the decisions made, e.g. multi-agent models.

- *Predictive/regressive/reconstructive models*: These analyse situations and events in the past in order to make predictions. They can simulate human behaviour and the evolution of a socioeconomic system (production or market) when faced with different stimuli or specific situations<sup>86</sup>. The predictive model is also an excellent tool for calculating, analysing and interpreting the balance between the intra-regional consumption and the extra-regional export of wine.

The following diagram shows three groups of predictive modelling that we consider essential for the development of our study, along with the different parameters that can be studied:



Other important questions that also need to be taken into account are as follows:

- *Technology*: In many cases the number and characteristics of the must processing, collection and storage systems are unknown and will therefore have to be estimated.

<sup>85</sup> G. S. MADDALA, *Econometría*, México, McGraw-Hill, 1985; A. PULIDO, *Modelos econométricos*, Madrid, Pirámide, 1987; J. M. WOOLDRIDGE, *Introductory Econometrics: A Modern Approach*, Michigan, State University, East Lansing, 2006; R. PEDACE, 'Ten Components of a Good Econometrics Research Project', in R. PEDACE, *Econometrics for Dummies*, Hoboken-New Jersey, John Wiley & Sons, 2013, pp. 307-314.

<sup>86</sup> Ph. VERHAGEN, *Case Studies in Archaeological Predictive Modelling*, Leiden, Leiden University, 2007.

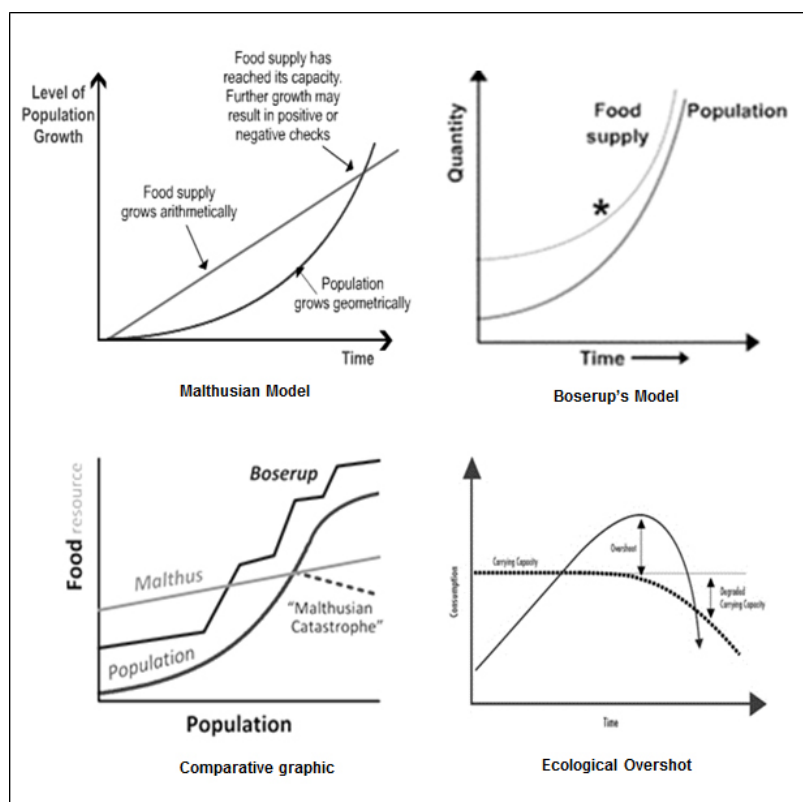
- *Rural settlements*: With typologies, clearly-defined functions and unequal density depending on the territory. Such factors are determined by social, economic and social strategies.

- *Associated artisan sector*: Systematic presence of activities complementing the main agricultural activity in most settlements.

- *Land ownership and distribution*: Existence/coexistence of small producers and big landowners who each organize agricultural production in their own way.

- *Interpretation*: This documentation has been interpreted as part of a rationally organized production system, which means heavy investment in technology and labour, capable of generating surpluses, well connected to a market system<sup>87</sup>. This vitivinicultural production system would constitute an important sector in the provincial economy, and its dynamism could bring opportunities for personal enrichment for some social groups and help them to rise.

- *Demography*: Phenomena like indiscriminate increases or decreases in income per capita, migrations, epidemics, wars, etc. can create significant fluctuations in population and situations of imbalance that can have a decisive impact and influence the evolution of this socioeconomic system<sup>88</sup>.



**Fig. 5. Comparative study of Malthusian & Boserup's demographic models with its carrying capacity & ecological overshoot.**

<sup>87</sup> REVILLA, *Viticultura*, pp. 84-86.

<sup>88</sup> Several demographical models must be considered on the analysis of relationships between population growth and optimization of food production (see figure 6).

## 5.2. The *confinium Hasta Regia-Gades*: GIS modelling in Roman agriculture and reflections on the *riparia-vinea* ratio

The difficulties involved in studying Baetican viticulture can be overcome by increasing the volume of the available, essentially archaeological data. However, there also needs to be a simultaneous renewal of the theoretical and methodological approaches. In this respect we present a brief reflection on the challenges and advantages of GIS modelling. This type of discourse runs the risk of becoming lost in the mass of possibilities provided by the methodology in question. We therefore propose to explain the subject by means of a case study. We will look at an investigation in progress to exemplify certain types of problem and probable solutions for other studies in the same area<sup>89</sup>. This research also returns with an alternative approach to the recurrent question of the weight of the Baetic references in Columella's imagery.

First of all it would be a good idea to point out one of the basic principles of modelling: it is not a question of reproducing a past reality as it was, but of representing possible realities. These different scenarios are obtained by varying the status given to a series of parameters established as determinants of the historical phenomenon we want to model<sup>90</sup>. Secondly, it is important to limit this choice, bearing in mind the resources available for the research<sup>91</sup>. Indeed there is a risk of establishing over-complex models in which the variability of the solutions makes a decisive approach impossible. Thus the applications in the sphere of Roman agriculture can range from resource-capture analysis<sup>92</sup> to agent-based modelling-ABM<sup>93</sup>. The case study we will describe had to cope with seriously limited means, hence the very specific nature of the research's guiding question. Despite this, the points for analysis resulting from the study involve significant issues concerning Roman agriculture and economy.

The case study involved an exploration of the agronomic ratio between *riparia* vegetation and vines. Works by the Latin agronomist Columella (Col. IV, 30, 2) establish the proportion of land on which plants that provide the necessary material for training vines should be grown. These plants included reeds, willows and osiers, which were necessarily or preferably grown next to water. Seen from a modern-day perspective and bearing in mind the geographically unfavourable context, carrying out research into the historical application of this ratio would be considered unadvisable. However, just like the amphorae, these materials had a value as *instrumentum* within the *fundus* and physical characteristics that perfectly matched their function. The Roman agronomic mentality therefore gave them significant economic weight and stressed the need to apply the template mentioned above. It remained to be seen how applying this theoretical principle would fare in a specific practical case.

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<sup>89</sup> D. MARTÍN-ARROYO, 'Modelización de la ratio *riparia/uinea*: el emparrado romano entre *Hasta Regia* y *Gades*', in L. LAGÓSTENA (ed.) *Lacus autem idem et stagnus, ubi immensa aqua convenit* (Isid. *Etym.* 13.19.9). *Estudios históricos sobre humedales en la Bética (II)*, Cádiz, Universidad de Cádiz, 2016; a first approach on the historical discussion and the study of case in D. MARTÍN-ARROYO & P. TRAPERO FERNÁNDEZ, 'La explotación romana de la vegetación *riparia* y el análisis espacial de la ocupación rural', in L. LAGÓSTENA (ed.), *Qui lacus aquae stagna paludes sunt* (Isid. *Etym.* 13.19.9). *Estudios históricos sobre humedales en la Bética*, Cádiz, Universidad de Cádiz-Seminario Agustín de Horozco, 2015, pp. 243-260.

<sup>90</sup> H. GOODCHILD, 'GIS Models of Roman Agricultural Production', in A. BOWMAN & A. WILSON (eds.), *The Roman Agricultural Economy. Organization, Investment, and Production*, Oxford, Oxford University Press, 2013, pp. 55 and 57.

<sup>91</sup> Th. CURRIE *et al.*, 'Agricultural productivity in past societies: Toward an empirically informed model for testing cultural evolutionary hypotheses', *Cliodynamics: The Journal of Quantitative History and Cultural Evolution*, vol. 6, num. 1, 2015, pp. 28-32.

<sup>92</sup> L. GARCÍA SANJUÁN, 'Introducción al reconocimiento y análisis arqueológico del territorio', Barcelona, Ariel, 2005, pp. 201-206.

<sup>93</sup> Application to agrarian systems: R. L. AXTELL *et al.*, 'Population growth and collapse in a multiagent model of the Kayenta Anasazi in Long House Valley', *Proceedings of the National Academy of Science of the United States of America*, vol. 99, num. 3, 2002, pp. 7275-7279. Historiographic background: M. W. LAKE, 'Trends in Archaeological Simulation', *Journal of Archaeological Method and Theory*, vol. 21, 2014, pp. 258-287.

The choice of spatial framework took into account the information available and the researcher's familiarity with the environment<sup>94</sup>. The aim was also to keep the margin of error small and limit the ranges of the variables. Alternative solutions to the actual proposals of the model could be suggested as well. An example of this would be the use of plants other than those recommended for training vines by Columella but which proliferate in the region. An area was therefore chosen between two former *territoria* of the *colonia Hasta Regia* and the *municipium* of *Gades*, in the Roman province of *Baetica* (Map 6). Here a collection of sites could be chosen, rural establishments that would have been active between 45 BC and 74 AD, coinciding with a particular phase of territorial planning and full implementation of the *villa* economic system. Most of this information comes from an archaeological record of the surface, detected in surveys. Excavations and palaeoenvironmental studies are few and far between. In short, this is a conventional context, with the usual determinants found in territorial studies of the Roman world. However, there are also definite advantages, mainly a clearly limited historical framework. The context is chronologically and politically defined and economically favourable for the development of viticulture, i.e. a fertile environment with good communications under the control of Romanized elites who would have been the driving force behind the investment.

The amphoric record needs to be inserted at this point in the debate, both as an argument and as an object of reflection in itself. The manufacture of wine amphorae in our area of study indicates the existence of production for export, but the bivalent character of known amphoric shapes poses problems of interpretation. Also, the possible existence of production for export does not necessarily presuppose the use of the vine-training technique because the vines could have been grown *sine pedamentis*. About 15 of the 73 sites studied (20.5%) produced amphorae, all within the chronological period stipulated<sup>95</sup>. Some types were used exclusively as containers for salted products (Dressel 7 and 8).

The others would have had a bivalent use, also containing different types of wine. The Dressel 1 would follow the Italic tradition in this respect. The *tituli picti* occasionally indicate the contents: *vin(um) d(efrutum)* (Mañá C2b), *lump(hatum) vin(um)* (Dressel 9 and Beltran IIA, and perhaps also the Dressel 11), *vin(um) amin(eum)* (Dressel 10) and *vin(um) r(ubrum)* (Beltran IIB)<sup>96</sup>. The nearness in shape of the Dressel 7-11 typological group, the most abundant in the area, makes it difficult to taxatively distinguish between productions of these types of pottery. Another question to address is the location of the pottery workshops. Some are inland and others near the coast, but in environments in which vines have traditionally been grown. The availability of resources, communications and the seasonal complementarity of spaces and occupations thus come to be included in the debate. The production of the fish sauces and salted products could have contributed to the inclusion of local wine and grape by-products in the overseas trade.

Some pottery workshops, like certain wetlands, are very close to the edges of our study area. However, the space chosen is analysed as an isolated unit, distributed like a Voronoi diagram on the basis of site locations. Enclaves on the periphery are excluded, thereby avoiding an "edge-of-map" effect. This perspective goes back to the agronomic ideal of the *fundus* as a self-sufficient space. In this paper the cartographic resources used to document the environment across which the ratio was

<sup>94</sup> D. MARTÍN-ARROYO, *Proyección territorial y colonización romana. El caso de Hasta Regia*, PhD thesis, Universidad de Cádiz, 2013.

<sup>95</sup> L. LAGÓSTENA & D. BERNAL, 'Alfares y producciones cerámicas en la provincia de Cádiz. Balance y perspectiva', in D. BERNAL & L. LAGÓSTENA (eds.) *Figlinae Baeticae. Talleres alfareros y producciones cerámicas en la Bética romana (ss. II a.C. – VII d.C.): Actas del Congreso Internacional (Cádiz, 12-14 de noviembre de 2003)*, BAR International series, 1266, Oxford, Archaeopress, 2004, pp. 61-66.

<sup>96</sup> <http://amphorae.icac.cat/>, [27/10/2015].



estimated will not be specified, but it would be advisable to add an epistemological reflection. The general lack of palaeoenvironmental analysis calls for caution when dealing with anachronisms in landscape reconstructions. Indeed it is best to choose study areas where no big physical changes are expected to have taken place between the Roman period and today. Certain palliative measures may be useful for most studies of this type, e.g. estimating a particular height above sea level to imitate the former coastline. The historical cartography must be taken into account, although the distortion of the data represented often makes them difficult to incorporate into a GIS. Other interesting sources in this regard would be pre-industrialization notary and land registry documents. In the case of the study mentioned earlier, a German map from 1940-1944<sup>97</sup> fortunately provides a solution. This document indicates the presence of wetlands that have disappeared as a result of today's technification of agriculture and even gives an idea of the area covered by vineyards.

Nevertheless, it could be argued that reconstruction is anachronistic, bearing in mind factors such as the vulnerability of certain wetlands to drainage works. In fact these infrastructures or the adaptation of river banks for landing stages would explain the location of certain enclaves in the area of study in spaces at risk of flooding. Then again, although the spread of crops depends to a large extent on cultural initiatives, the physical determinants would have had to have similar weight for all preindustrial technologies. However, while the true likeness of the phenomenon modelled in the area is important for weighing up the results, it must be taken into account that this concerns an idealized recreation with independent objectives, in this case a comparison between an agronomic ratio and a defined geographic space as laid out in the German map. This comparison could be extrapolated to other places which, in Roman times, satisfied the characteristics given for the GIS model. In short, this is a partial examination of the source in question and of Latin agronomy in general, as a theoretical discourse, in relation to the economic and geographic realities of Antiquity.

The preliminary results of applying the ratio indicate a highly unequal distribution of the *riparia*. This goes against the agronomic principle of the self-sufficiency of the *fundus* with its *instrumentum*. However, these results can be modelled because the vines could have been grown in varying proportions over the total available land. A different kind of consideration would give a grouping coefficient to the Voronoi sectors, which could create more sustainable theoretical *fundi*. There are plenty of strategies that can be used to reformulate the model. It is also a good idea to note down any reading of particular coherence. The total area analysed supplies a ratio of 8.9% *riparia* compared to the 9% indicated in the agronomic texts. This leads one to reflect on how unattached property could counteract the unequal distribution of the *riparia*. Although the transporting of materials from outside the property was not recommended, their nearness or favourable communications could weaken this rule. In this respect we could consider the information supplied in a notary protocol dated 1514 from a different historical context but close in conceptual and geographic terms<sup>98</sup>. It shows a sowing configuration similar to the one Cato (*R. R.*, VI, 3-4) proposed for the *riparia*, reinforcing the idea of practices and patterns repeating themselves. The crop in this case was grown on an irrigated site separate from the vineyard which it would have had to supply. Thus using unattached property to produce *riparia*-type *pedamenta* is suggested as a probable solution in both the model and the historical parallel. Modelling therefore seems to be a useful tool for increasing historical knowledge in general and knowledge of Roman viticulture in particular.

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<sup>97</sup> Cartografía del Estado Mayor del Ejército Alemán, 1:50.000, 1940-1944 (MTA50R\_1944). Instituto de Estadística y Cartografía de Andalucía.

<sup>98</sup> Archivo Municipal de Jerez de la Frontera. Archivo Histórico de Protocolos Notariales. Escribano Luis de Llanos. Tomo 32 bis C. fols. 1161r-1163v. 9 de diciembre de 1514, Jerez de la Frontera

## 6. DISCUSSION AND CONCLUSIONS

This paper aims to provide a state of the art and suggest future lines of research about the importance of wine economy in Roman Hispaniae.

The nature of the information available and the various hypotheses put forward in recent decades enable us to pose a series of question which it seems possible to answer only via the creation of models of various types (economic, econometric, agent-based and/or predictive/regressive/reconstructive).

Some of these questions involve the nature of agricultural systems. Can the relationships between settlement patterns and agricultural exploitation systems be defined? Is it possible to identify a series of vitivinicultural production unit “types” and calculate their capacities and yields in absolute terms? Is it possible to “reconstruct” the interests, strategies and behaviours of rural landowners - defining certain categories - in relation to how an economic activity is organized or a particular property exploited? How might other factors such as forms of employment, the tax system, commissions and commercial margins have an influence? Other questions force one to look at the relationships between social structures and the economy, specifically the relationship between wealth generated by the wine economy and the social rise of individuals who took on the management of certain activities.

Yet more questions have to do with the possibilities of analysing the economy of the Hispanian provinces. Can the specific weight of viticulture be determined in relation to the weight of other known economic activities in the various *regiones* and *territoria*? Is it possible to establish a general study model to enable subsequent economic research into all these productive and commercial matters and their application to other territories?

In this context it is essential, first, to combine the analysis of archaeomorphological aspects and landscape archaeology with the study of the different variables that play a part in wine production. In this perspective it will be possible to draw inferences about agricultural productivity. More specifically, there are a number of issues that should be analysed in depth: technofunctional aspects relating to agricultural instruments, the machinery and structures used in the grape-treading and pressing process, winemaking techniques and processes and the various storage, packing and shipping systems, the product’s transport and distribution process, and the wholesale and retail trade process.

The intensive use of analysis tools, mathematical and statistical models and linear programming will make it possible to study, interpret and make predictions, regressions and reconstructions of ancient economic systems. We will therefore be able to calculate the production potential of a region or territory, regional consumption and how much of the surplus could be commercialized in foreign markets. Other variables such as the selling price, market reactions, production and transport costs, business trends and the consequences of economic policy will also need to be taken into account.

Our opinion is that, in order to be able to extract reliable macro-economic, meso-economic and micro-economic conclusions about the vitivinicultural production in a particular territory in Roman times, one of the first objectives should be an in-depth analysis of how the production chain functioned in that spatial and sociocultural context.

After that, efforts should be made to establish settlement patterns and exploitation typologies, define their evolution and develop what in classical economic theory would be called economic production models. These in turn are capable of being studied at micro-economic level. In this

area consideration is given to factors such as the calculation of yields, the production function, the appropriate use of production factors (land, workforce, capital, technology and knowledge), the structure of production and commercial costs and the system of prices and profits.

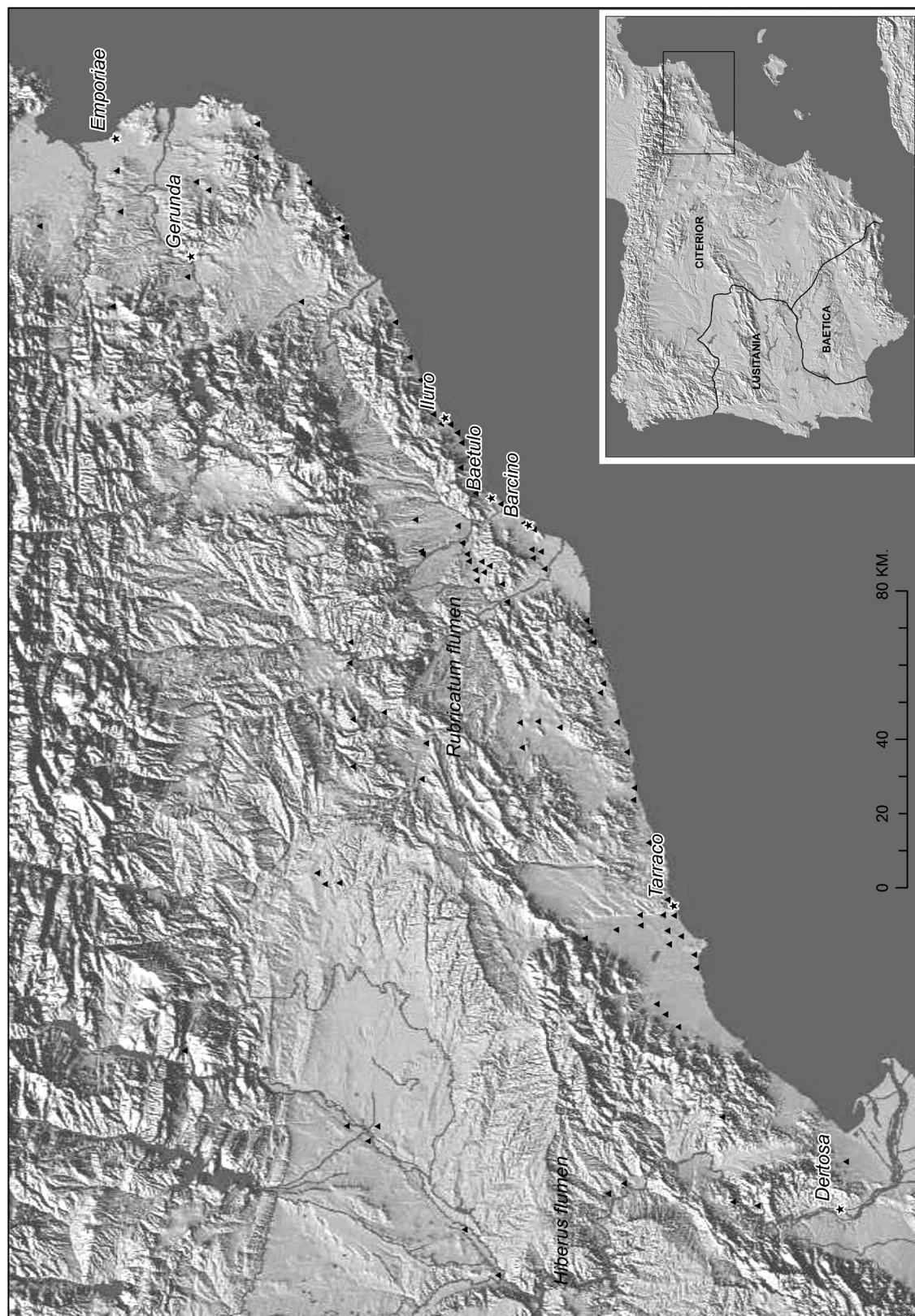
Subsequent efforts will be aimed at transforming these theoretical models into econometric models<sup>99</sup>. Econometrics provides the tools for the empirical analysis of economic theory, whether to verify it or to test the hypothesis of a model of relationships between variables. With econometrics the numerical values of the variables are analysed, not only their behaviour or general trend. It is also to test - in our case using historical and/or archaeological quantitative data - suggested or existing economic theories, to develop predictive/regressive economic models.

The ultimate aim of this study will therefore be to try and obtain absolute quantitative data on the subject, not only for the different stages of viticulture - growing, harvest, grape processing - but also for viniculture - pressing, storage, winemaking, packaging - in the different vitivinicultural facilities documented in the area of our object of study. From this point the meso-economic study of different scenarios will allow possible patterns to be drawn to enable us to study in greater detail the organization and evolution of the different agricultural concerns over time.

The use of econometric models along with the application and development of predictive/regressive/reconstructive models based on the identification of theoretical economic and productive vitivinicultural models of Roman times and their evolution over time in a specific territory thus becomes a new line of research that will no doubt make it possible to study in greater depth the production, distribution, commercialization and consumption of wine in Roman times.

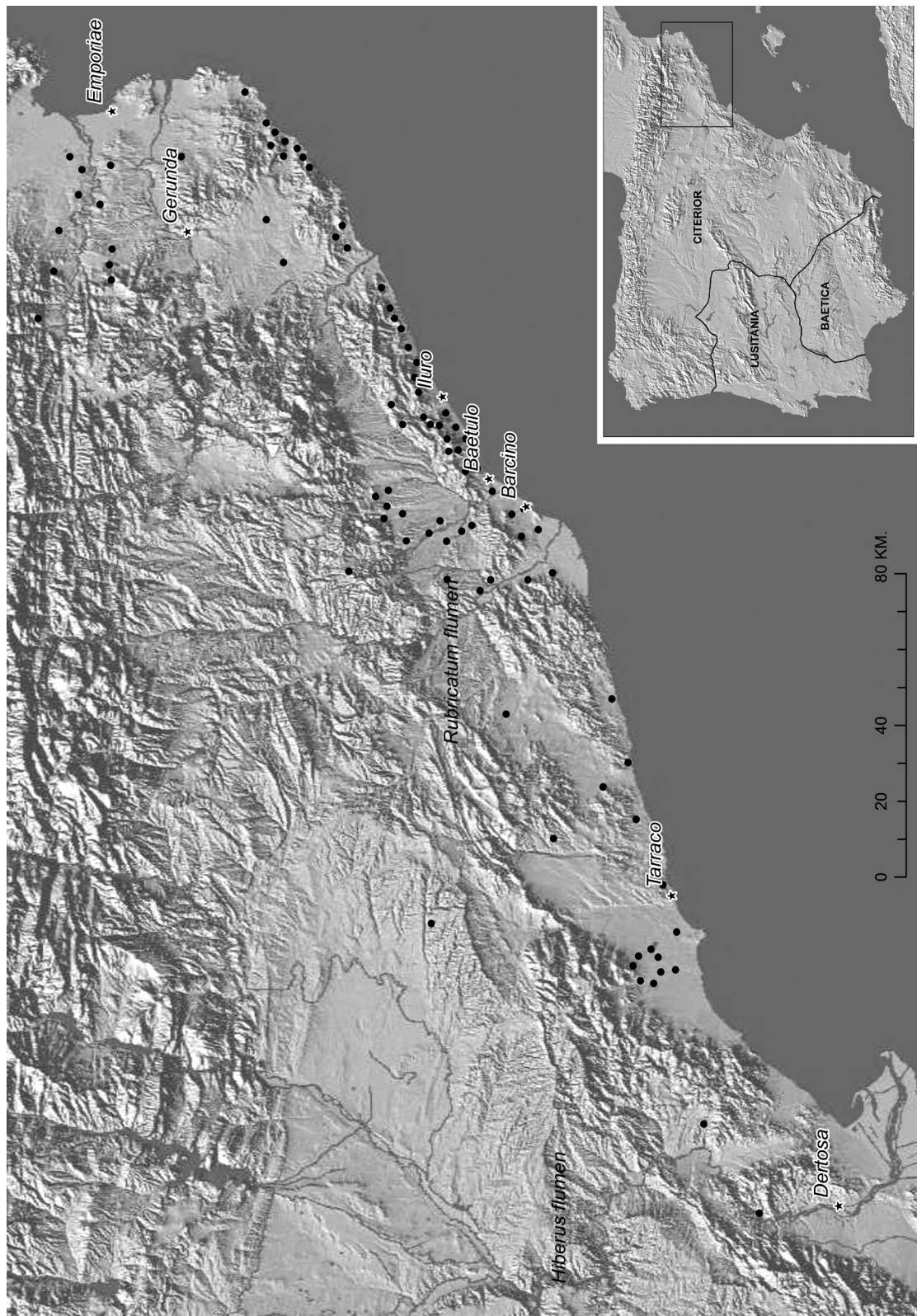
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<sup>99</sup> J. L. SANPEDRO, *Realidad económica y análisis estructural*, Madrid, Aguilar, 1959.



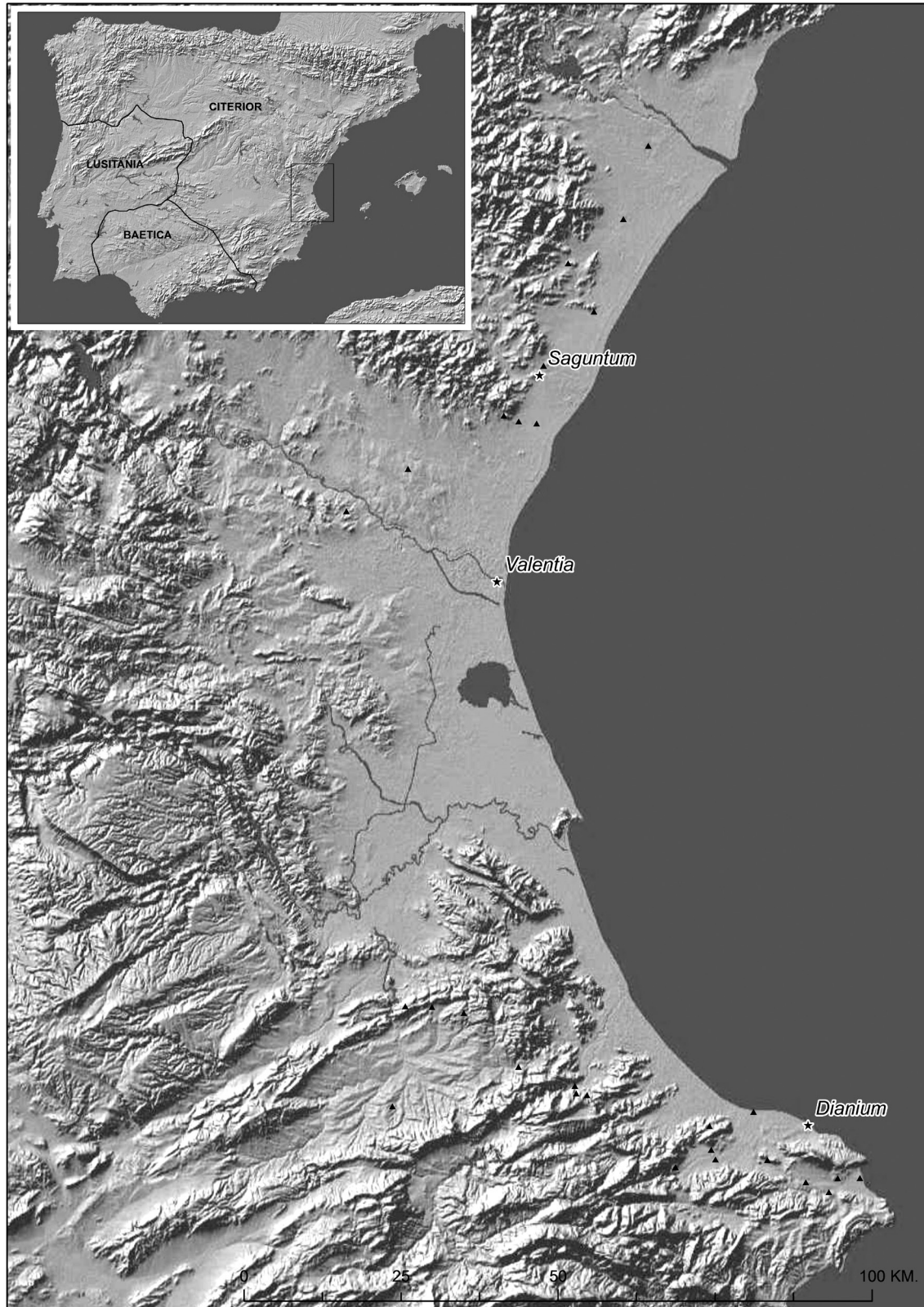
Map 1. *Torcularia* of north-eastern *Hispania Citerior Tarraconensis*. GIS data: D. Martín-Arroyo 2016.





Map 2. Figlinae of north-eastern Hispania Citerior Tarraconensis. GIS data: D. Martín-Arroyo 2016.



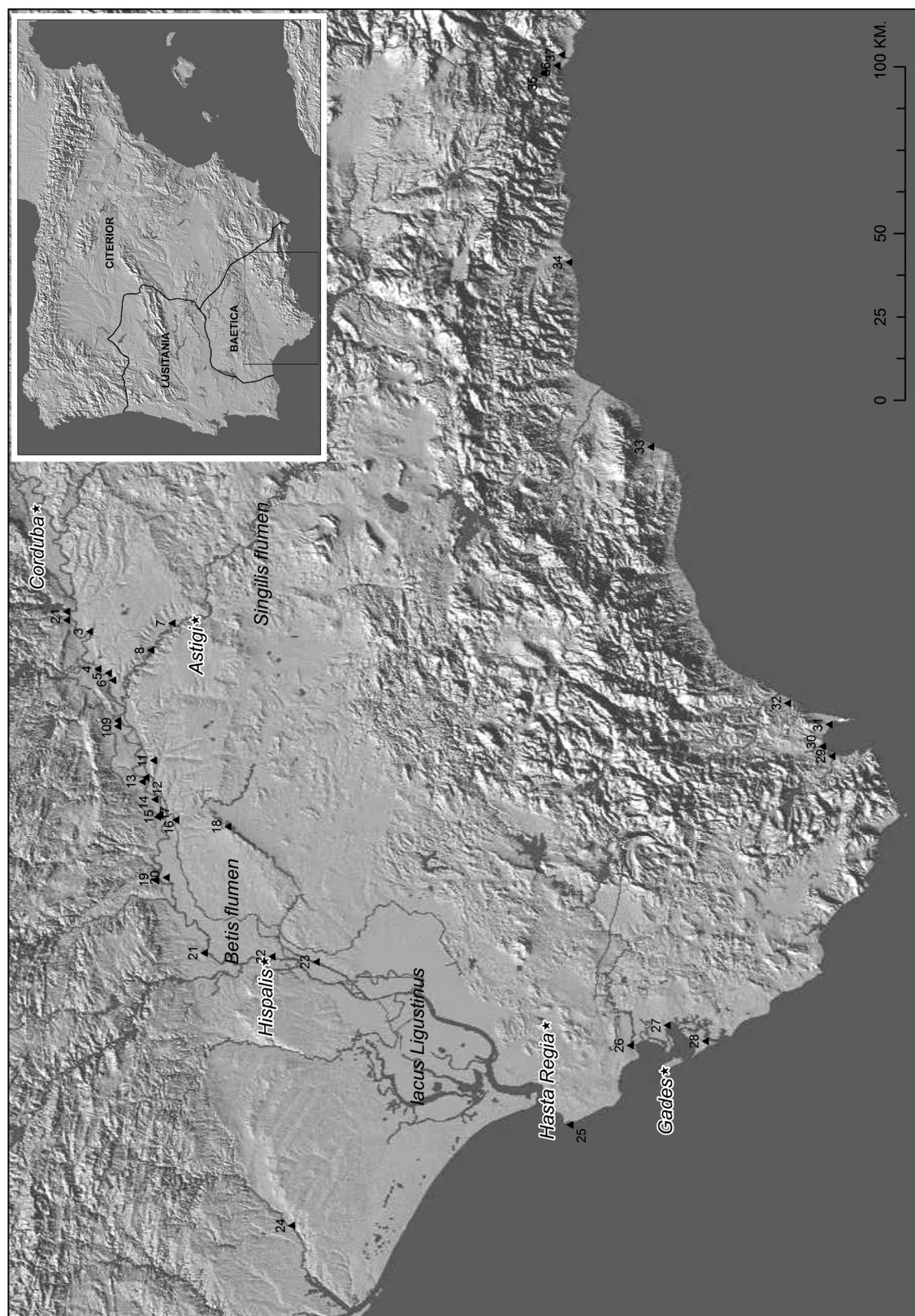


Map 3. *Torcularia* of east central coast of *Hispania Citerior Tarraconensis*. GIS data: D. Martín-Arroyo 2016.

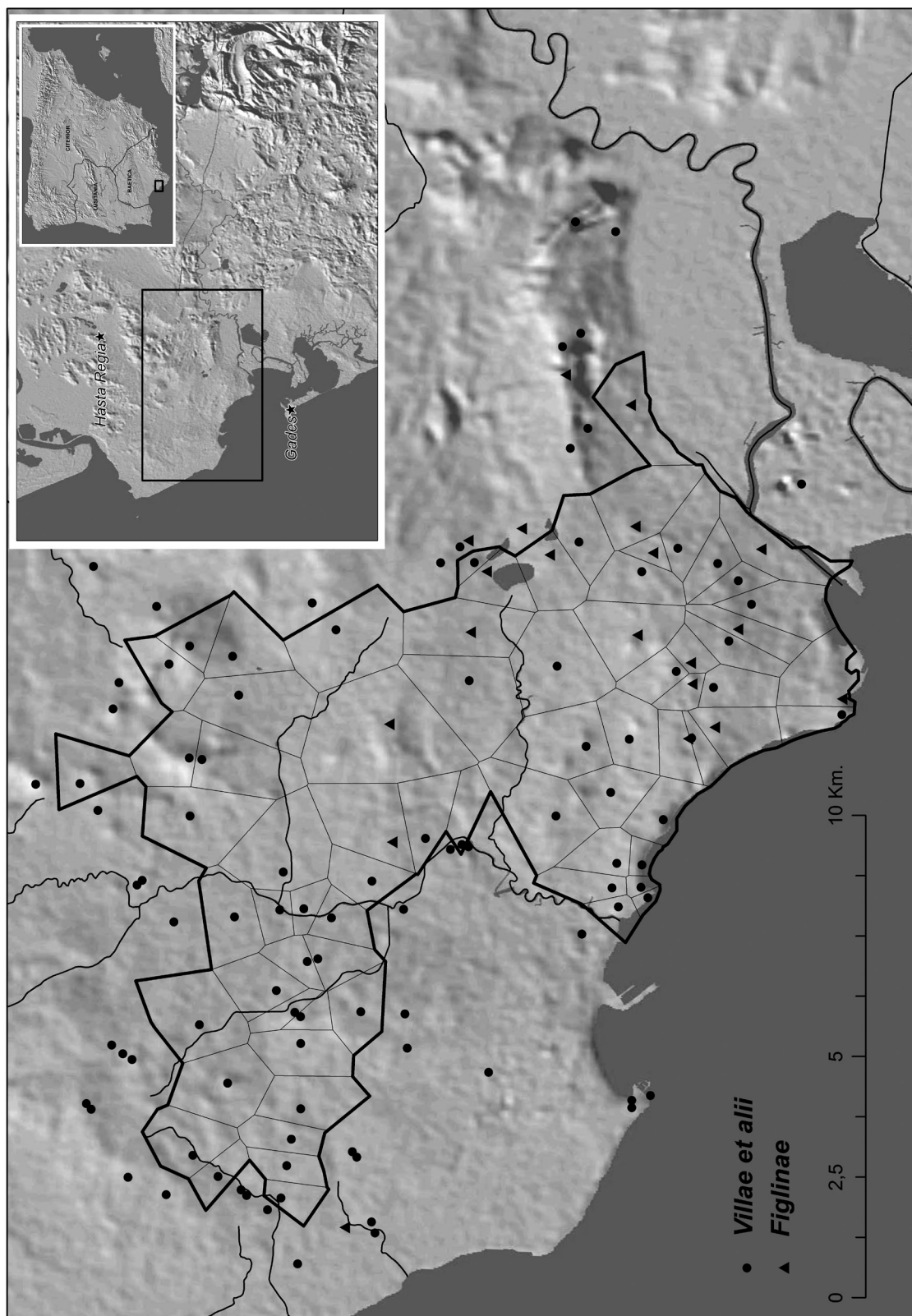


Map 4. *Figlinae* of east central coast of *Hispania Citerior Tarraconensis*. GIS data: D. Martín-Arroyo 2016.





Map 5. *Figlinae of Hispania Ulterior Baetica* according to Table 1. GIS data: D. Martín-Arroyo 2016.



Map 6. Historical & geographical framework for GIS modelling of riparia-vinea ratio.



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